POWER PLANT ENGINEERING

Trade mark reg. U. S. Pat. Office

VOL. XXIII. CHICAGO, SEPTEMBER 15, 1919 No. 18

Handling Coal and Ashes with Electric Hoists

TYPES OF SYSTEMS AND APPARATUS USED IN SEVERAL MODERATE SIZE PLANTS. BY JAMES MONROE

WE CAN LOOK at a steam plant as a factory for the production of mechanical or electrical power. The raw material is usually coal, and the waste product the ashes. These must be handled scientifically and economically.

With painstaking labor we have all arranged exacting tests to show us how to obtain the highest possible boiler efficiency. We are continually checking up the B.t.u. value of our coal. How carefully we regulate the draft, and watch the CO_2 percentages, and flue gas temperatures! We look diligently for the slightest leak in setting or baffle. The dust must fly from the boiler tubes. These are the big things that count in getting boiler efficiency. Mechanical stokers and forced draft systems have proved an immeasurable boon.

But isn't the vital question, how much does it cost to make this unit of power, this horsepower-hour, this kilowatt-hour? It is a broader problem than that of getting 65 or 70 per cent boiler efficiency. The investors look at it in this way. Are we paying enough attention to the labor costs, which are daily figuring more and more in the ultimate cost?

Of course, the big fellows—those plants with their 30,000 kw. turbo-units—are taking no chances with the

FIG. 1. MONO-RAIL HOIST SYSTEM AT PLANT OF AJAX RUBBER CO.

labor market. They have cut the human element to a minimum with the latest equipment for handling coal and ashes; but what about the small plants, so many of which started with a battery of two or four hand fired boilers, and have been extended from year to year? As a rule, no mechanical provision has been made for handling the ashes, and scant provision for the coal. Re-

is dropped from the cars into a track hopper, then carried by inclined conveyor to storage, as is clearly seen in the cut. A one-ton electric hoist controlled from the ground, with a three-quarter-yard bucket carries the coal an average of about 100 ft. into the boiler house (Fig. 2), where it is discharged into the hoppers of the stokers. The boiler house contains five 300-hp. boilers,

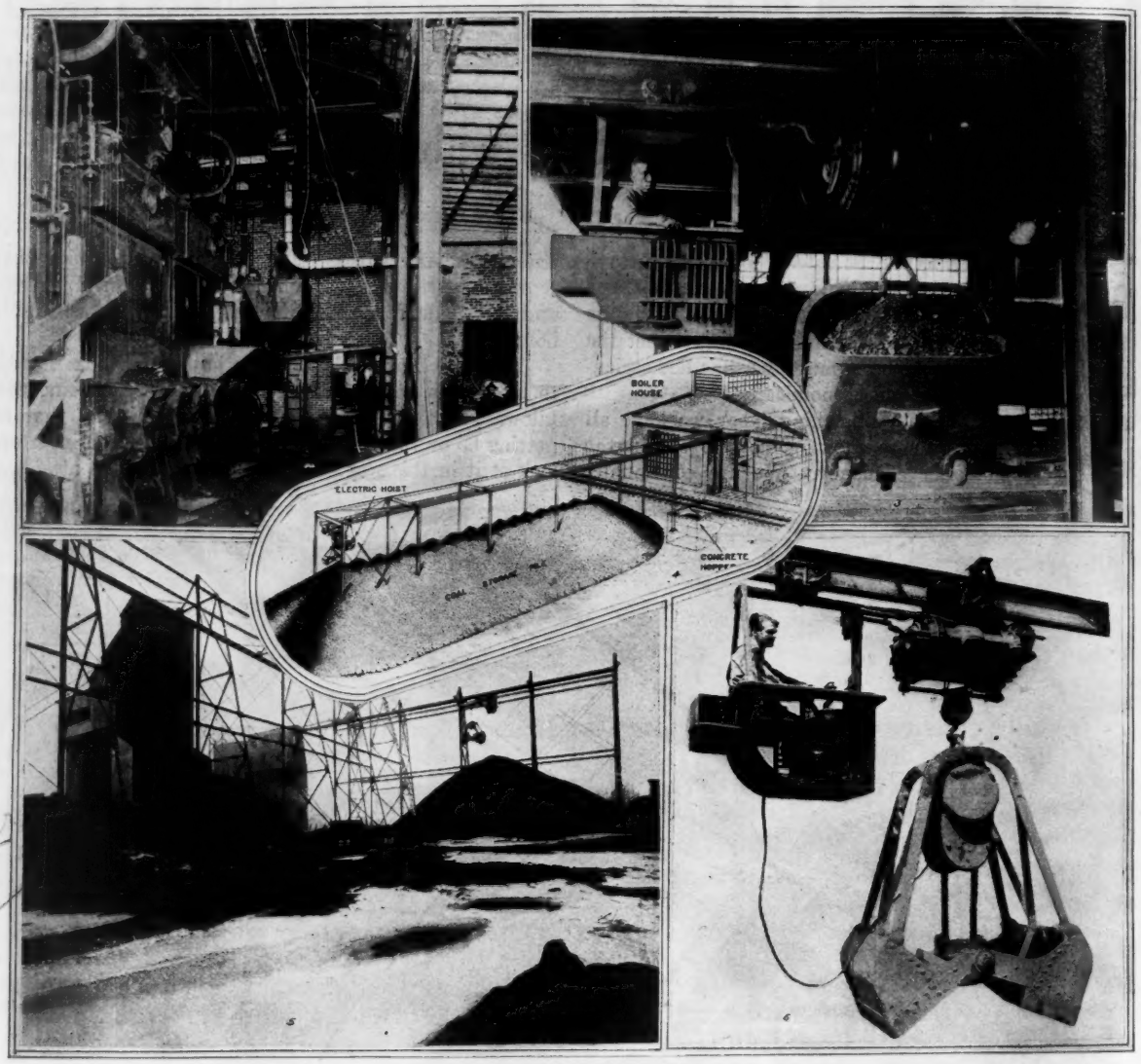


FIG. 2. BOILER ROOM OF AJAX RUBBER CO. PLANT

FIG. 3. CAGE OPERATED HOIST IN PLANT OF MASSILLON ROLLING MILL CO.

FIG. 4. DIAGRAM OF MONO-RAIL SYSTEM FOR STORING AND RECLAIMING COAL

FIG. 5. SINGLE LINE BUCKET MONO-RAIL EQUIPMENT FOR HANDLING COAL AND COKE

FIG. 6. ELECTRIC CLOSING BUCKET USED IN COAL HANDLING

member that the coal situation is not going to be very much improved over last winter—coal must be stored, and sufficient to act as insurance against shut-down.

In these old plants, and many new ones moderate in capacity, a mono-rail hoist system lends itself very readily to the economical handling of both the coal and ashes. A hoist with enclosed gears should of course be used.

Figure 1 illustrates a nicely laid out system at the plant of the Ajax Rubber Co., Trenton, N. J. The coal

and the daily coal consumption is 40 to 50 tons. Two men per shift fill and handle the bucket.

The hoist performs the very important function of reclaiming the coal and dumping it into the stokers. The reclaiming of coal from storage is never a simple problem unless an overhead bunker is used, and in many cases first cost forbids the installation, while the cost of the hoist and runway is very moderate.

A similar equipment, complete with runway, could

be installed today for about $4000. To show the saving gained by this hoist, we will compart the cost of operating the boiler house with and without it:

Yearly cost of operation with hoist—	
Interest on investment at 6 per cent	$ 240
Depreciation and repairs, 8 per cent	320
Cost of current at 10c per kw.-h	126
Labor—two men day shift, two men night at, say, $1000 per man per year	4,000
Total	$4,686

Without this equipment, at least three men per shift would be required to wheel the coal and shovel into the stoker hoppers, making a total labor expenditure of $6000.

Saving—$1314.

These figures are very conservative, and in all probability two men per shift are being saved. Only three firemen per shift are now employed to fire the four boilers in use, while it is customary to have one fireman per boiler when coal is shoveled by hand. It is important to note that the repairs and cost for current average very low for this type of machinery, especially when all gears run in oil, as in this case.

Suppose we carry our hoist design one step farther. Figure 3 shows the cage operated type, in operation at the Massillon Rolling Mill Co., Massillon, Ohio. This is usually used where the amount of coal to be handled warrants employing an operator. This installation has proved a great money saver, and in efficiency has excelled the expectations of the company.

We can still go another step and equip our hoist with a single line bucket for reclaiming the coal. Diagrammatic cut, Fig. 4, illustrates a simple coal storage system, in which the coal is discharged into a pit from railroad cars. It is picked up by the bucket and taken either directly into the boiler room and delivered into the stoker magazines, or piled on the ground under the mono-rail track. Figure 5 shows one of these installations for handling coal and coke at a public utility gas plant in Wisconsin. The next view is of a machine designed for lighter duty, equipped with a three-quarter cubic yard electric closing bucket.

The problem of handling ashes mechanically is daily becoming more urgent. We are confronted with the fact that, with the coal we are getting, ashes have been running 20 per cent of the coal consumption, and in many cases higher. This is true even with improved methods of combustion. The capacity of many old plants has been increased 100 per cent by the installation of stokers and forced draft systems; so that with this increased capacity, of course, the total amount of ashes increases, even allowing for increased efficiency.

Provision should be made for carrying away the ashes as quickly as possible, before they begin to accumulate in large quantities and have to be rehandled. Many successful designs call for overhead bins for temporary storage, and they cut down the handling charges very appreciably. In other cases the ashes may be carried directly to car or carts, and carried away without delay.

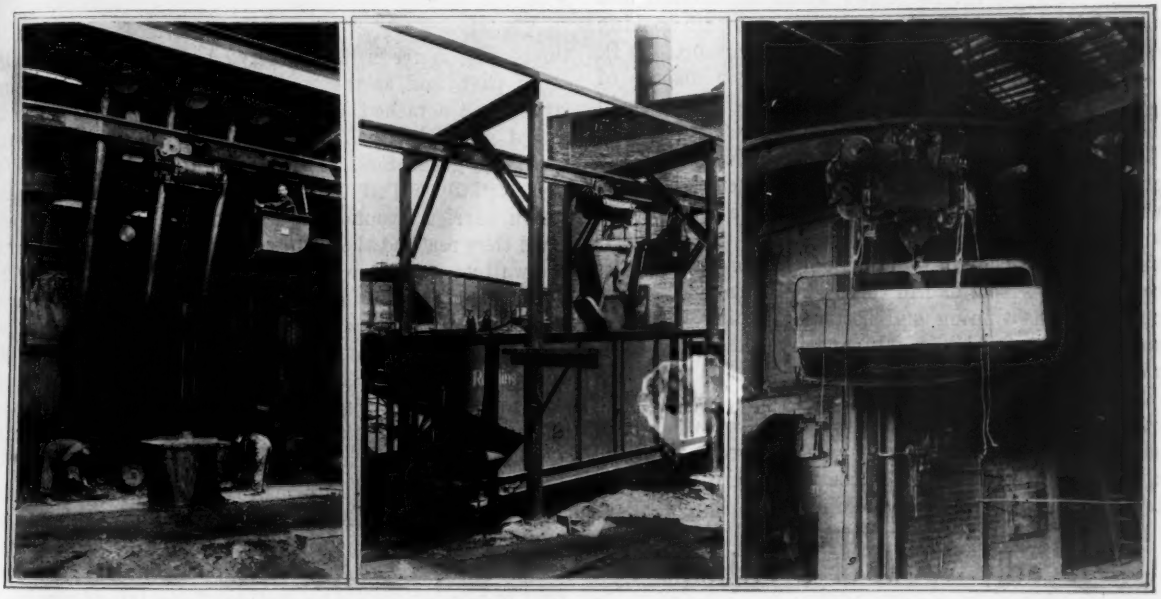


FIG. 7. FILLING BOTTOM DUMPING BUCKET FOR HANDLING ASHES
FIG. 8. DUMPING ASHES INTO A CAR
FIG. 9. MONO-RAIL HOIST HANDLING ASH TRAY

A cage operated hoist with bottom dumping bucket lends itself very readily to the handling of ashes, especially when they are pulled out on the boiler room floor. The Philadelphia Paper Co., of Manayunk, Philadelphia, have obtained excellent results with an equipment of this type. Figure 7 shows the machine in the boiler house, while in Fig. 8 it has run out over a gondola car, into which it is dumping the ashes.

About 30 tons of ashes are handled daily. They are pulled out every 6 hr. Two men do the work of shoveling, and occasionally a third is employed in operating the machine. The bucket holds 1¼ cu. yd. and is handled by a two-ton hoist.

This equipment is very compact and requires little

head room, a most important consideration in installations of this kind, where it is necessary to get a large bucket over the side of a high gondola car.

Another clever and simple method of handling ashes is to locate a few pits somewhat larger than the bucket in front of the boilers and directly beneath a mono-rail track. These are covered by a floor plate or frame in which is a large square hole, covered by a hinged trap door. When the fires are to be cleaned, the plate is lifted out by the hoist, the bucket dropped into the pit, and plate replaced with the trap opened. The ashes are then pulled directly into the bucket and carried away. With a hoist, the handling of these floor plates is, of course, a simple matter.

Figure 9 shows an interesting scheme worked out by the Pennsylvania State College for removing ashes from beneath underfeed stokers. A large steel tray is carried on a truck running on tee-rails beneath the dumping grates. Every 8 hr. the ashes which accumulate are dumped into this tray, which is moved to an opening then lifted by the hoist and carried to the dump, 300 ft. distance. It requires less than 10 min. to dispose of the ashes from under the boilers and return the trap in position for the next dumping.

Having mentioned these varied methods for the economical handling of coal and ashes with electric hoists in moderate sized boiler houses, it might be well to state more definitely the sizes and capacities that are frequently used. The hoists most popular for such service are those, say, from one to three tons in capacity. The buckets of the tipping and bottom dumping type will range from ½ to 1½ cu. yd. capacity. The single line or electrically operated buckets from ¾ to 1 cu. yd.

To sum up the advantages in installing electric hoist equipment, we have mentioned the low first cost, low maintenance and operating charges and great saving in labor. With the demand for coal storage, plants of all sizes must be prepared to handle it economically.

Deadly Work of Flywheel

Bursting Member Kills Engineer and Does Property Damage to Extent of $35,000

ON AUGUST 15 at about four o'clock in the afternoon a very serious accident occurred at the Sattley Building, Racine, Wis., in which one engineer lost his life and a property loss of $35,000 occurred.

This accident was caused by the bursting of an engine flywheel. The damaged engine was, according to information received from C. W. Spahr, a 16 by 42 in. Filer-Stowell Corliss, operating under a pressure of 125 lb. and at a speed of 90 r.p.m. The engine, which was equipped with a flywheel having a diameter of 14 ft. and a 26-in. face, was belted to a 200-kw. direct-current generator and a 150-kw. alternating-current generator, the two machines being driven by separate belts carried over the single flywheel. The flywheel which gave way weighed 8 tons and the pieces went into the Wallis Tractor factory, tore a hole through a 12-in. wall and struck a machine at which Wm. Dedrichs was working. Another piece weighing over a ton was carried about 500 ft. into the air, going completely over the building and landed into the yard of a foundry 350 ft. distant.

In speaking of the accident, Geo. H. Wallace states that "the governing mechanism was in its usual good working condition, as was evidenced by the fact that the engine was found after the accident, merrily running at its usual speed, with nothing to balance it but the six heavy spokes."

The outer belt driving a direct-current machine was but a few years in service, while the inner one used in connection with the alternating-current machine was part of the original belt formerly used to run a line shaft originally driven by this engine. While the latter belt was the older of the two, yet examination of the torn sections show the double-ply leather to be in good condition.

"Just what caused the accident," states Mr. Wallace, "no one appears to know, possibly not even the engineer who was killed."

The theory which seems to be the most plausible is this: The inner belt may have broken, either wholly or in part, and as the engine ran under the loose end struck and detached a number of boards out of the belt guard which inclined upward under the floor level toward the generators. These, with the belt, also probably partially rolled up by the re-action of the break, which carried around the wheel under the outer belt until they reached the point where the wheel was nearest the wall where they wedged. This obstruction if present was probably opposite one of the wheel joints as one was found with bolts intact in half of the joint while the other half was fractured so badly that it detached itself entirely from the rim bolts. The instant the first fracture was made the centrifugal force would tear the rims off the spoke which broke at the point of smallest section, that is, next to the rim.

Mr. Wallace was informed that immediately preceding the crash the voltage on both generators raised considerable, in fact enough to speed up the motors and to cause some of the lights to burn out. This might lead one to believe that a section of the lap of the inner belt tore a few bolts off the belt guard which went around under the belt and naturally increased the belt's speed for the time being. This sudden load thrown on the engine would cause the governor to drop, then admitting more steam to take care of the increased load. A small particle of grit might have lodged on the counterpoise and wedged the governor down until the increased speed overcame it, but not, however, until the wheel was wrecked, after which the governor again gained control of the engine.

The incompleteness of the wreck makes it impossible to determine positively the cause of the disaster, as the engine room immediately surrounding the engine was a mass of shattered glass, bricks, splintered timber and twisted and broken iron. All of the coils of the alternator were torn off the rotor and scattered about while the shaft was bent about 35 deg. All the wires on the pulley side of the direct-current machine of both the field winding and the armature were completely severed by the flying debris, and both pulleys, which were of the wood-rim-and-iron-spoke type, were smashed into small pieces.

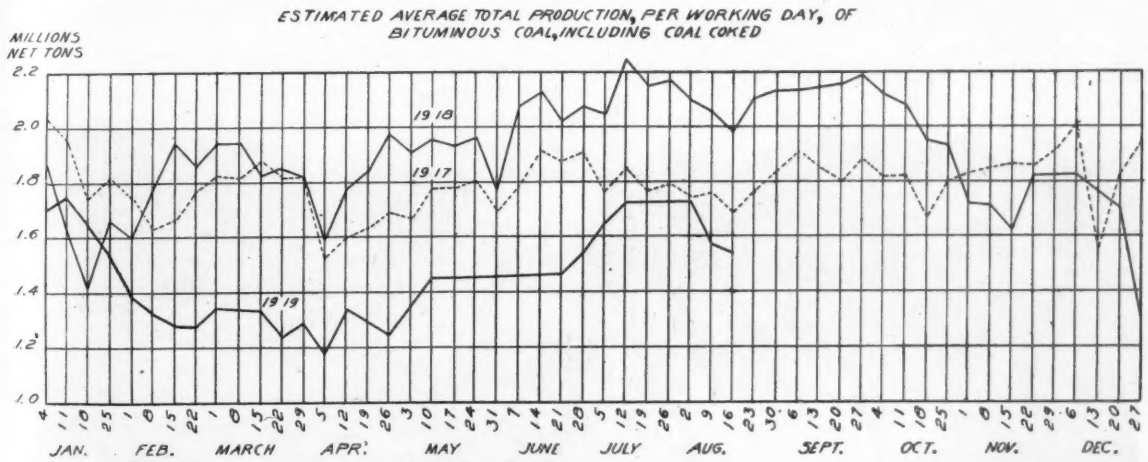
FUEL CONSERVATION LETTERS

By Joseph Harrington, Formerly Administrative Engineer for the State of Illinois

Storing Coal as a General Policy. Letter No. 17

WE heard a great deal about coal storage during the war; but how many of those who stored coal did it with a full comprehension of its importance?

The storage of coal seems to me to have a parallel in the storage of water by damming a mountain stream and then letting it out in controlled amount during the dry season. This comparison may not be exact in all respects, but illustrates the principle of ironing out the inequalities of production and consumption by placing a reservoir or storage between the two ends of the line. The consumption of coal is very largely seasonal, whereas the production ought to be continuous, uniform and steady in order that the producers could work advantageously without interruption to their income or wages. In the Fall, when domestic buying is at its height, there is a grand rush for appropriate sizes of coal; and in the Spring when the Winter seems far way, nobody is interested and all delay buying until such time as everyone else wants his fuel and thereby impose a terrific strain on both the production and transportation systems. Nothing more fundamentally wrong economically could be conceived; and the remedy lies in the hands of the general public. Only by public education can this economic disease be eradicated.



Storage of coal mined east of the general vicinity of Pittsburgh offers no especial difficulties, and no excuse can reasonably be offered for failing to observe the ordinary business precaution of buying during the advantageous season. As we go farther west, however, we encounter practical difficulties in the storage of the high volatile coals, and special precautions must be observed in piling them up for future use. Enough has been learned, however, about coal storage to make it practically a safe proposition. Certain simple and easily observed rules must be followed and your coal will stay in place without firing or deterioration.

The cost and difficulty of rail transportation in the Winter is much greater than in the Summer and the hazard of a rail tie-up is infinitely greater. With a hand-to-mouth coal delivery, the risk of a plant shut-down is vastly increased and the prudent owner or manager sees to it that there is enough fuel on hand to carry over any moderate stoppage in deliveries.

January and February are the months of the year when the railroad transportation is most likely to be interrupted; and this gives a guide to the amount of storage that should be provided for. By the first of the year, enough coal should be in storage at every power plant to carry over at least sixty days. By thus taking out of the market this much coal, the shipments of absolutely necessary domestic coal are assured.

There is a certain insurance in all of this that is good business. The good business man will not overlook a form of insurance which is relatively inexpensive but which may insure his output during the cold weather. Without doubt, the loss of a few days output would many times offset the total cost of the necessary storage. Bulletins describing the proper methods of storage have been issued by the Engineering Experimental Station of the University of Illinois and by the Bureau of Mines, which may be had at slight expense.

Developing Hydroelectric Power Sites

SUMMARY OF FACTORS WHICH MUST BE CONSIDERED. ADVANTAGES OF INTERCONNECTING SYSTEMS.

POTENTIAL water-power developments are receiving increased attention for various reasons. Improved load factors resulting in decreased power costs have been of great assistance. Expansion of high-voltage lines to transmit power economically over distances up to 200 miles has also improved the status of hydroelectric power, by making possible the utilization of more remote water power sites.

Many recent discussions have sought to combat the popular but mistaken view that any hydroelectric plant will produce power at a lower cost than steam. To discriminate between the worthy and the commercially impractical projects, the most careful investigation is required. A brief review of the more important considerations may assist in eliminating the rather vague idea of the procedure.

FIG. 1. LONG LAKE DEVELOPMENT, SPOKANE RIVER, WASHINGTON.

In determining the feasibility of developing a water power site, the following preliminary factors must be thoroughly considered:

(1) Actual value of the necessary property and the price asked. (2) Height of the fall which occurs at the site of the proposed development and the distance in which this fall takes place. If the fall occurs in a long distance, the construction work to utilize the water will be more expensive than if the fall occurs abruptly. (3) Flowage rights included in the title of the property. Always fully investigate the laws relating to streams of the state in which the development is to be made. (4) Variation in the quantity of stream flow, and the amount of water power available at minimum flow. (5) Assuming that the proposed site is adjacent to a market where power may be sold, the estimated cost of complete development should be secured from a competent engineer. (6) Make certain in advance of the market for power, not only of the immediate probable demand, but what the future market may be. Note particularly whether any other power sites are available for development within a reasonable distance from the territory which the projected plant will supply. If so, it should be brought under the control of the owner of the project under consideration, to eliminate possible future competition. Proximity of undeveloped coal fields and other power sites that may become power producing competitors must be included in a study of the situation. An estimate of the rate at which power can be sold is then made. (7) Annual profit. Government reports are the most reliable forms to consult in checking up these considerations.

If it is now certain that the project is practicable and will prove profitable, the necessary legal proceedings should be instituted for organizing the company and securing the necessary franchises and rights.

LEGAL RIGHTS.

FEDERAL permits are nearly always required for the development of 75 to 80 per cent of the potential water supply of the country, chiefly in the western states. These permits are revocable, and numerous attempts

have been made to enact legislation which would offer more satisfactory rights for the development of these water-power sites.

In territory not subject to Federal restriction, legal right to erect and maintain a dam may be required: (1) By virtue of ownership of the land on which it is constructed; (2) by grant from public authorities; (3) by deed from private land owners, and (4) by long assertion of right.

In the absence of contrary legislation, an owner of land along a non-navigable stream is entitled to erect a dam on his own land, without regard to the rights of upper and lower riparian owners, if the quantity of water which would naturally flow through the lands of the lower owners is not appreciably diminished, and also subject to liability of the upper owners for overflow on their property.

State legislatures have the power to authorize the construction of a dam across a non-navigable stream. In common practice, a special act of Congress is required to authorize the building of a dam across a navigable river. Legislative permission to construct a dam does not exempt the owner from liability for resulting injury to the private property of others.

Water Available for Power.

In the engineering examination, the work is divided into two classes. A hydraulic engineer determines the flow of the stream and makes preliminary plans for the reservoirs, dams and other hydraulic equipment. Installation, transmission and distribution problems are worked out by the electrical engineer.

As a stream drains a certain territory, the extent of this water shed has an important bearing upon the amount of flow and its regularity. The hydraulic engineer's report should contain maps showing the position, character and extent of the water shed. Tables should be included showing the rainfall, runoff and evaporation data which applies to the water shed. Records of the flow of many rivers have been kept for a number of years, and when this data is available and presented with confirmatory gagings, an estimate of the flow over the dam is fairly accurate.

In many instances, the report will indicate that if the flow of the stream could be supplemented during certain months of the year, a much greater amount of power would be available. Data is then offered showing the quantity of water required to be added to produce the desired amount of power. Where it is possible to store this water by building reservoirs, information is furnished regarding their size and cost. If storage is impractical, steam power may be installed as a supplementary power and tables are presented showing how much mechanical power is necessary to maintain a certain output.

Location of Dam and Power Station

In direct or low-head developments all the available fall is utilized at the dam, and the power house is located at one end or in the interior of the spillway. This plan is favored because of concentration and savings in operating costs and because of its affording the highest possible hydraulic efficiency of the fall and flow of the water.

Diversion systems, known as the medium- or high-head developments, have a diverting dam with an intake at the head waters, from whence the flow is led to a forebay pond. In a diversion system the slope in canals and flumes, friction head in pipe lines, leakage, evaporation and ice conditions sacrifice a portion of the available head. This system of development is employed where the location of the power house at the dam is not feasible because of contraction of the river channel, or of the insufficient height of the spillway to accommodate the power equipment in its interior pipe in accordance with the volume to be utilized.

Locations of impounding dams for creating water storage are determined by the topography of the water shed.

Dams are ordinarily classified according to the material used in their construction, as: timber crib, earth-fill,

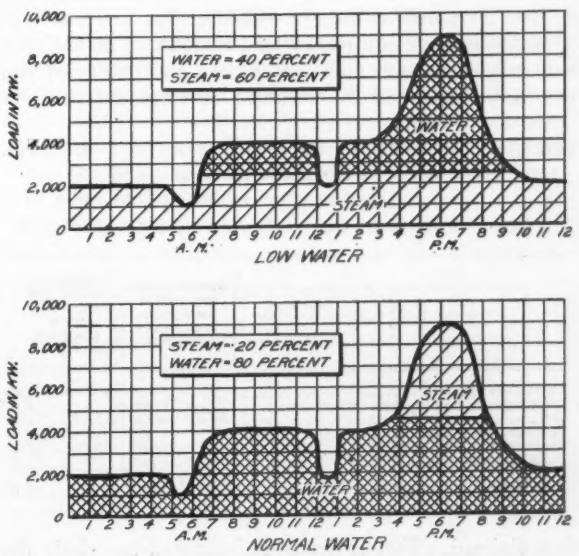


FIG. 2. TYPICAL DIVISION BETWEEN STEAM AND WATER POWER LOAD.

rock-fill and masonry dams. Choice of type is generally determined by natural conditions. With solid rock foundations, masonry dams are commonly employed. Absence of rock foundation may compel the use of the crib or other type of dam.

Before a final decision can be reached as to the exact location of a dam, it is always advisable to dig or drill a number of test holes, especially where solid rock is not available, to determine the character of the underlying strata. With low-head development, the flooded area has been ascertained to determine the available head. It is now important that the dam should preferably be located at a point where the river banks are steep, so that a sufficient pondage and head can be obtained without the flooding of too much adjacent land.

Factors Affecting Cost of Development and Return on Investment

Hydroelectric plants cost considerably more per unit of capacity than steam plants, due to the expenditures for riparian rights, erection of the dam and other hydraulic features, the right of way and long distance

transmission lines. Unlike the steam plant, the hydroelectric station must be built largely with a view to future possibilities and not the actual market, and thus carries an excessive overhead for years.

Although the initial cost of power site development is great, the running cost of hydroelectric power consists mainly in the item of interest money on the capital represented in the initial outlay. Apart from administration, insurance, taxes and depreciation, virtually the entire burden of gross operating expense is assumed at the outset. The table is a unit analysis of the gross operating expenses of a typical steam-electric and hydroelectric station of similar capacity (20,000 hp., 50 per cent annual load factor; coal at $3.25 per ton delivered) given by Gano Dunn in the 1916 proc. A. I. E. E.

High costs of hydroelectric transmission lines, particularly in mountainous country, has made power-site development prohibitive in many cases. It has been suggested, electric transmission lines be considered as a special type of transportation equipment, and established on the common-carrier basis. This will nearly halve the interest rate now demanded by electrical development projects,

TABLE I. COMPARISON OF GROSS OPERATING EXPENSES BETWEEN TYPICAL STEAM AND HYDROELECTRIC STATIONS.

	Steam station (per cent of total gross operating expenses).	Hydroelectric station (per cent of total gross operating expenses).
Administration	4.0	4.0
Ordinary operating expenses (except coal)	10.6	4.8
Coal	48.9	
Taxes and Insurance	6.7	2.8
Depreciation	10.8	11.0
Bond interest	19.0	77.4
Total	100.0	100.0

it is claimed. The service to be rendered is strictly distributive and of public service order; and competition is out of place to the same extent as in other public-utility and common-carrier systems.

What the cost of current shall be to provide a profitable return on the total cost of development, requires a thorough study of existing conditions in the districts to be served. It is mainly determined before the site is developed, but subject to revision to meet prevailing conditions or special demands of the various classes of service. In naming different prices for various loads, hydroelectric companies may conveniently classify the service into five headings: (1) Electric lighting; (2) motors under 25 hp.; (3) motors under 300 hp.; (4) virtually continuous load; (5) power of electric railway and lighting companies.

As the development cost of a hydroelectric plant is about three times as great per unit output as a steam-electric station, the selling price of hydroelectric current must contain a greater proportion of gross profit, to yield the same return on the investment.

Interconnection Advantages

Development of high-tension transmission lines has materially aided in the establishment of interconnecting water power systems. This plan has been notably demonstrated in our southern states, where seven large systems are tied together, furnishing power to each other on an "interchange" contract basis. Advantages of interconnection are obvious. Peak loads of different systems may not coincide, and the minimum stream flow may occur at different times on the different watersheds.

Interconnecting hydroelectric and steam-electric plants have become common practice for emergency and supplementary service. Reserve steam plants serve as stand-by for breakdown, relay for low water, supplementary for carrying peak loads, and as base-load capacity when load exceeds the water power, and water power becomes supplemental to steam.

In Fig. 2 curves have been drawn to indicate graphically how a typical system load is divided between the water power and a supplemental plant. Here the load exceeds at all times the water plant capacity, calling for the daily use of steam to carry part of the load. During normal water, water power serves as the base load, while in low water season, steam is employed to better advantage as the base.

Operating in North and South Carolina, the Southern Power Co. supplements the output of its five hydroelecertic stations having a total output of approximately 100,000 kw. with the power of three 8000-kv.a. steam stations. The entire system is also interconnected to the Carolina Power Co., which operates two hydroelectric and three reserve steam plants. Naturally the steam plants are located largely with reference to an economical coal supply. Reserve power plans have been developed by the Tennessee Power Co., with the Chattanooga Railway and Light Co., the Nashville Railway and Light Co., and the Knoxville Railway and Light Co., whereby the steam plants of these three cities may be operated at the direction of the Tennessee Co., when reduced stream flow requires such additions.

Painting Galvanized Iron

By Mark Meredith

GALVANIZED IRON is finished in a bath of palm oil, and as a matter of course, some of this oil, a very thin film, adheres to the metal and prevents the perfect adhesion of the paint, especially if the iron is fresh from the mills. To remove this film of oil and also to give a more perfect surface for the adhesion of paint, various washes have been recommended by various authorities. Prepare a mixture of ½ oz. each of copper chloride, copper nitrate and sal ammoniac.

Place these in a glass or earthen jar, and add 1 qt. of soft water, stirring occasionally, until all are dissolved; then add ½ oz. of commercial hydrochloric (muriatic) acid. This will coat about 500 sq. ft. Apply with a broad, soft, flat brush. The metal will at first turn nearly or quite black, but will change to gray in a short while. When dry it is ready for paint. Some have found that washing the new iron with a strong solution of carbonate of soda, rinsing with clear water and rubbing dry before painting, produced satisfactory results. Again, washing the iron with strong vinegar (practically diluted acetic acid), rinsing with clear water and rubbing dry, or letting the iron stand after rinsing for a week or more, answers the purpose. In priming galvanized iron or zinc, yellow ochre ground in linseed oil and thinned with varnish adheres to the metal better than any other mixture.

Vacuum---II

ADVANTAGES OF LOW PRESSURE; CONTROLLING CONDITIONS. BY ROGER TAYLOR

THE ADVANTAGE resulting from the reduction of the back pressure by the vacuum on the steam engine, either reciprocating or turbine, is that an increased amount of heat energy per pound of steam is given up and transformed into useful work. The lower the absolute back pressure, the greater is the amount of heat available from each pound of steam, for conversion into work with adiabatic expansion of the steam from any given initial pressure. This is shown in Fig. 3.

Take steam at a pressure of 165 lb. absolute. Every pound of water converted into steam at this pressure contains 1193.3 heat units above 32 deg. F. This heat is transmitted to the engine by the steam and a portion is available for conversion into work, the balance being rejected to the condensers.

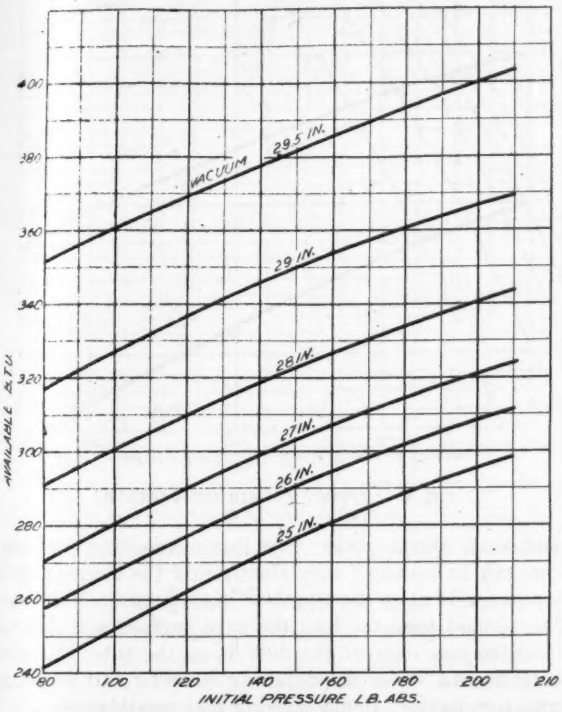


FIG. 3. RELATION BETWEEN DEGREE OF VACUUM, INITIAL PRESSURE AND B.T.U. AVAILABLE FOR WORK

The amount that is converted into work depends entirely upon the range of pressures between the initial and final state of the steam. Let steam at a pressure of 165 lb. absolute be exhausted against the atmosphere, the amount of heat remaining in the pound of steam will be 1018 heat units and the amount utilized in doing work 175 heat units. Let the back pressure be reduced to 28 in. vacuum by further adiabatic expansion, then the heat remaining in the steam will be 870 units to be rejected and the amount utilized 323 units. By decreasing the back pressure $28 \times 0.491 = 13.75$ lb. the units available for work have been increased from 175 B.t.u. to 323 B.t.u., an increase of 84 per cent.

A kilowatt-hour is equivalent to 3412 heat units. With a turbine converting all of the heat units available into useful work, under the above pressure conditions, the theoretical water rate when exhausting against the atmosphere would be $3412 \div 175 = 19.4$ lb. of steam and when exhausting against 28 in. vacuum $3412 \div 323 = 10.5$ lb. of steam. These water rates are based on the assumption that the efficiency is 100 per cent.

In practice the rates will be higher than these by an amount sufficient to overcome the various losses, thermal and otherwise. They are of value, however, in indicating the reduction in the water rate possible, by reducing the exhaust back pressure, since the available energy is increased in this manner, particularly at the higher vacuum, where the increase is very rapid, the gain being very much more for the last few inches than for the first few inches. As the kilowatt-hour has this definite value in heat units (3412) it follows that if the pressure conditions are such as to make a greater amount of heat available, then the pounds of steam necessary to produce the kilowatt-hour will be reduced and the unit will be more economical.

Figure 4 is a typical water rate curve of a 5000-kw. turbine based upon steam conditions at the throttle of

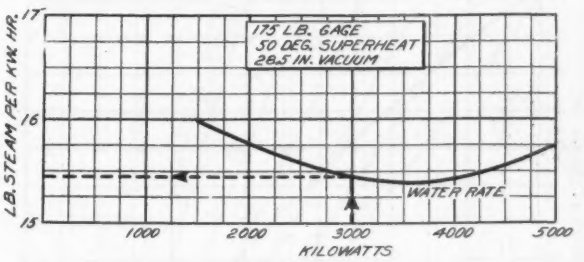


FIG. 4. TYPICAL WATER RATE CURVE FOR 5000-KW. TURBINE

175 lb. gage, 50 deg. superheat and 28.5 in. vacuum. Figure 5 is plotted to show the effect upon the steam consumption of variations from the specified vacuum of 28.5 in. If the observed vacuum is 27.5 in., the ratio of the heat input at this vacuum to that of the specified vacuum is 107 to 100, or an increase of 7 per cent, and with an observed vacuum of 29 in. the heat input will be 95 per cent of that necessary for 28.5 in.

From Fig. 4, with 3000 kw. on unit, the water rate will be found to be 15.46 lb. per kilowatt-hour when operating with 28.5 in. vacuum, if the vacuum is 27.5 in. Following the line as shown on Fig. 5 to the curve and then horizontally to the left, shows that for the lower vacuum of 27.5 in. the input will be 7 per cent more, or $107 \times 15.46 = 16.51$ lb. per kilowatt-hour. With 29 in., the water rate will be 14.66 lb.

This curve is plotted to show the effect of vacuum changes on this unit and of course is not applicable to others unless working under the same pressure and temperature ranges. It is based on the assumption that the water rate is proportional to the heat input per pound of steam, which may not be quite strictly correct for large changes in vacuum from the specified value, due to the fact that the unit is designed at the lower pressure stages

for steam conditions corresponding to 28.5 in. and with other vacuum the density of steam is changed, and since the blade areas remain constant there will be a change in the velocity of steam through these blades. With higher vacuum than that specified, this will result in an increased residual velocity of the steam. Although the actual water rate may not show all the beneficial results to be expected from the higher vacuum figured in this manner, still they are of sufficient magnitude to warrant striving for.

Conditions Affecting Vacuum

The amount of vacuum obtained depends upon a number of conditions: the volume, temperature and velocity of cooling water circulated; the number of heat units to be absorbed from the steam, which, in turn, depend upon the load and steam rate of the unit; the condition as regards cleanliness of the cooling surface; the rate of air infiltration to the condensing system and the degree of perfection of the removal of this air.

It is to be assumed that the design of the condensing equipment is such as to give the maximum vacuum for any given set of conditions of load and injection water temperature (these values are usually given by the builder's guarantee) and any drop in vacuum from those

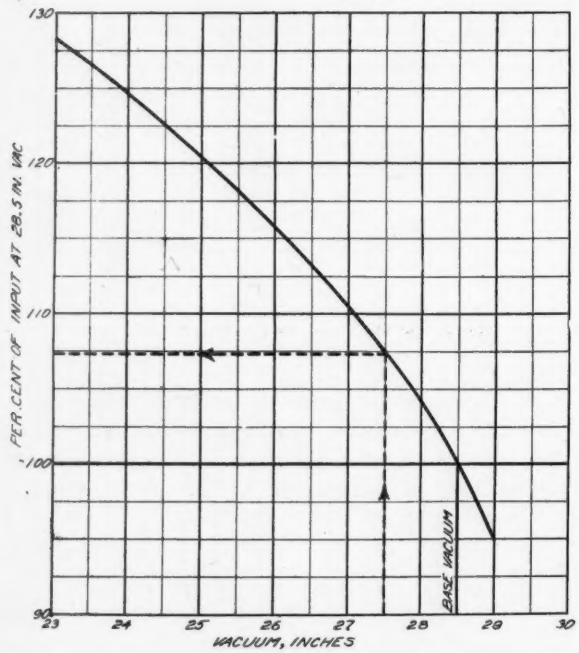


FIG. 5. EFFECT ON HEAT INPUT OF VARIATION IN VACUUM

values, under those conditions, must be attributed to other influences. The two factors influencing the vacuum that the engineer may be able to control are the cleanliness of the cooling surface and the air leakage to the system.

As regards the first, cleanliness, too much attention cannot be paid to it, as its effect upon the rate of heat transmission is, of course, very pronounced. The frequency with which the tube surfaces should be cleaned depends entirely upon the character of the circulating water used and often upon the season of the year. In the spring and fall, considerable trouble is often experienced by leaves and debris washed down from the river banks by freshets and floods, so that no definite time can be placed upon the cleanings. Experience and test readings taken periodically and compared with readings taken following cleanings will usually form somewhat of a guide to be followed.

Too much emphasis cannot be laid upon the necessity of checking the condenser performance at least daily, if not oftener, such check to include readings of load, vacuum, barometer, circulating water temperatures and

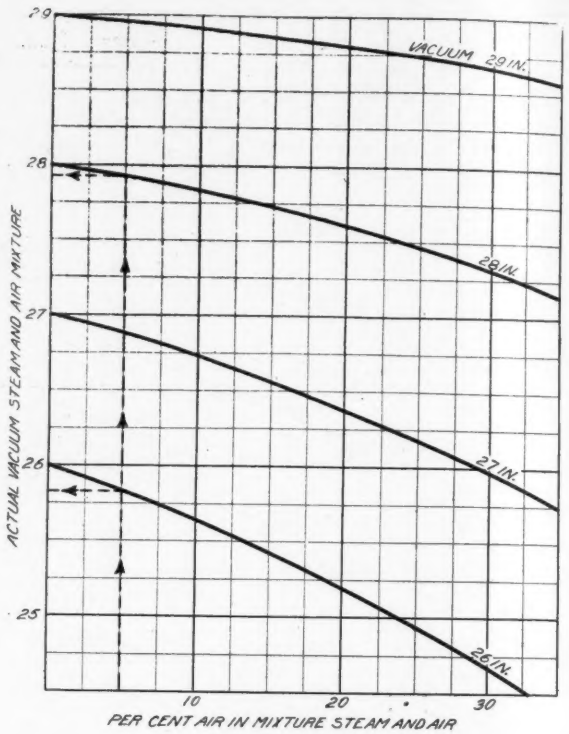


FIG. 6. EFFECT OF AIR ON VACUUM

condensate temperature. By this means, the performance can be followed very closely and the engineer will have a guide as to the length of time between cleanings. The method used to clean the tube surface will depend upon the character of the deposit on the tube. Several methods can be used, including washing, air blowing, brushing, baking, steam blowing and sandblasting.

If the deposit is of a slimy form, excellent results can often be obtained by washing with water at high pressure, or even blowing out with air, although the latter is not so effective as the former if there is considerable deposit within the tubes. The time required can be reduced materially by using a nozzle head that will take 3 or 4 tubes at one time. Brushing where a brush of a spiral form is blown through the tube with water or air is very effective, provided the deposit is not too hard. If the deposit is too hard to be removed by any of these methods, recourse may be had to baking or steaming. These methods, however, have the disadvantage of tending to make leaky tube packing. Steam is turned into the condenser steam space around the tubes, no water, of course, being circulated through the tubes. This has a tendency to expand the tubes, the scale breaks loose from the metal and can then be washed out.

Sandblasting, in which a small quantity of sand is blown through the tube by air, is very effective in removing the harder scales and does not appear to have any detrimental effects upon the metal. This method, however, is rather tedious and requires considerable time. In addition to the tube surface being cleaned periodically, it is in many plants necessary that the tube ends be kept in a clear condition by frequent cleanings. The

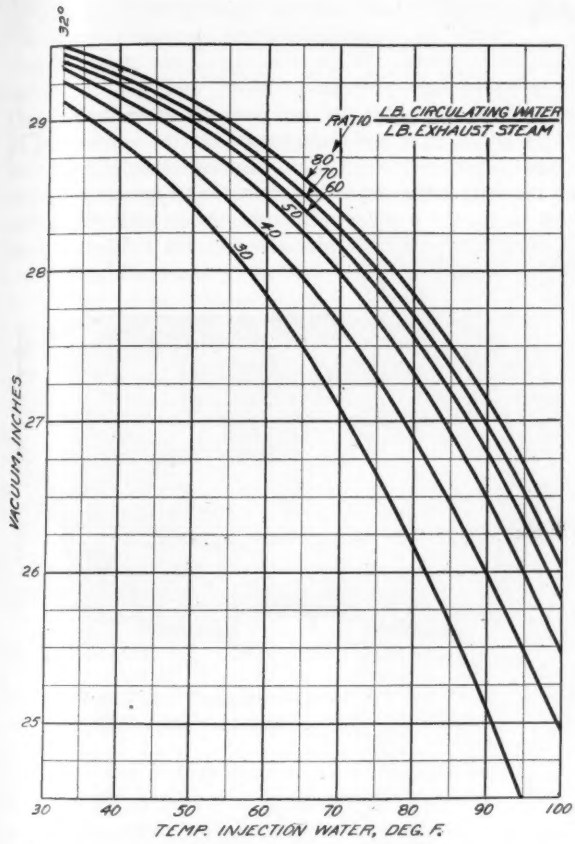


FIG. 7. EFFECT OF INJECTION TEMPERATURE ON VACUUM

reason for this should be obvious, as it means a considerable reduction in the volume of cooling water circulated if a number of the tube ends are plugged or stopped. A very good indication of this condition is given by a gage on the discharge of the circulating pump, which should be installed if not already present. Naturally as the resistance is increased through the condenser by the stoppage of the tubes the discharge pressure will rise, and by this it can be judged when the condenser tube ends require cleaning.

The effect of the air in the condenser on the vacuum can be seen by reference to Fig. 6. Assume that under certain load and injection water temperature conditions, a vacuum of 28 in. should be obtained, and that there is present in the condensing system 5 per cent of air in the air and steam mixture. Rising vertically along the 5 per cent line to the 28 in. curve and then to the left gives 27.92 in. as the actual vacuum obtained. Note that the effect of 5 per cent of air on 26 in. theoretical vacuum is greater, the actual vacuum being 25.83 in. So that the effect of a given amount of air is much more pronounced at the lower vacuum than at the higher. It must be remembered, however, that the available heat increases at a very rapid rate at higher vacuum and while the drop in vacuum may appear quite small its effect upon the steam consumption may be great. The air present may be quite a large amount, part entering the condenser with the steam having been carried to the boiler in solution in the feed water and thence to the turbine and condenser.

Ordinarily the air carried to the condenser in this manner is quite small, for by the use of open feed water heaters, the amount of air carried to boilers in the feed water is usually negligible, this type of heater being very effective in air removal. By far the greatest amount of air will enter the system at those points where the pressure is below the atmosphere, so that care must be taken to keep all such parts of the system absolutely tight in order to reduce the leakage to a minimum. Pipe joints, turbine joints, atmospheric relief valves and turbine shaft packings are some of the places where considerable air may be entering the system, particularly at

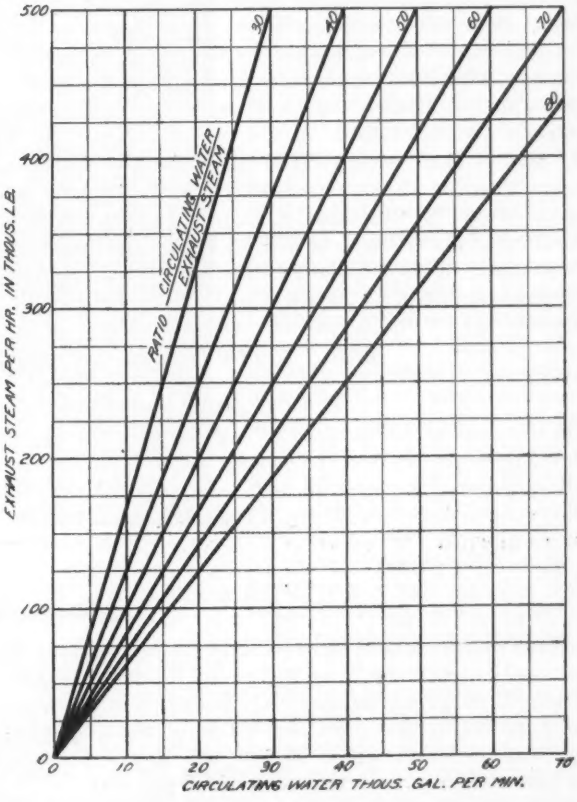


FIG. 8. RATIO OF CIRCULATING WATER TO EXHAUST STEAM

the latter points. The necessity of efficiently removing the air, in addition to keeping the amount as low as possible by close attention to the leakage, should be clear. Aside from the fact that air present in the condenser reduces the vacuum by an amount equal to its pressure, it has the effect, inasmuch as it is a very poor conductor of heat, of retarding the efficient transmission of the heat from the condensible vapors, at such points within the condenser as it may be gathered or blanketed;

so that the air removal apparatus should be maintained in the best possible condition, in order to insure the rapid removal of the air.

Then the two factors influencing the vacuum, which are more or less under the control of the engineer, are the questions of cleanliness and air leakage. Other factors affecting the vacuum are possibly more related to the design of the condenser, as the cooling area, resistance to steam flow, number, length and size of tubes. The effect of load conditions must be considered and the effect of seasonal changes in the injection water temperature upon the vacuum obtainable. These are not within the province of the engineer to control. There is, however, still another factor to which careful attention should be paid; that is, to the circulating water pumps, in order to insure that the requisite volume of water is being circulated. There has been in recent years a large increase in the ratio of circulating water to condensed steam, in order to obtain the high vacuum now used. An arbitrary value of 1000 B.t.u. is often used as the amount of heat given up by each pound of exhaust steam; others use the value corresponding to the heat contents of the steam after adiabatic expansion. It is probable that the true value will be at some point between these two; however, 1000 B.t.u. is much more convenient to use and may afford a greater margin of safety in figuring the ratios of water to steam.

Assume that, with 1000 B.t.u. to be absorbed per pound of steam, the vacuum is 28.5 in. The temperature of the steam, t_s, will then be 90 deg. F. Let the temperature of injection, t_0, be 60 deg. F. and the final temperature, t_1, of the circulating water be 10 deg. F. below the exhaust steam, or 80 deg. F. Then R., the ratio of circulating water to exhaust steam, will be $R = \frac{1000}{t_1 - t_0} = \frac{1000}{80 - 60} = 50$ lb.

Let the ratio be increased to 65 and the same difference in temperature between the exhaust steam and final circulating water temperature or $t_s - t_1 = 10$ deg. F. and the injection as before, 60 deg. F. Then t_1 final temperature will equal

$$\frac{1000}{65} + t_0 = 75.3 \text{ deg. F.}$$

and the vacuum should correspond to the temperature of $75.3 + 10 = 85.3$ deg. F. or 28.7 in., an increase of 0.2 in. Figure 5 will give some idea of the reduction in the steam consumption by this additional 0.2 in. of vacuum, showing that the steam rate at 28.7 in. will be 98.5 per cent of that at 28.5 in. or a reduction of 1.5 per cent.

This would mean a considerable saving in fuel if carried throughout the day's run. References to Figs. 7 and 8 will make clear the influence of load, injection temperature and volume of water circulated, on the vacuum obtainable. Note that with a given water injection temperature of, say, 60 deg. F. on Fig. 7 there is a gradual increase in the vacuum with increased ratio of circulating water to exhaust steam; also note how rapidly the theoretical vacuum obtainable decreases with the higher temperature of injection water and constant ratio of circulating water to exhaust steam. Figure 8 shows the effect with a constant volume of water circulated, of an increase of load upon the ratio of circulating water to exhaust steam, the ratio decreasing as the load is increased. An analysis of the two curves will show that it is manifestly impossible to maintain a constant vacuum under all conditions of load.

Oxy-Acetylene for Pump Repairs

A SAND SUCKER chamber that had become badly scored through use was recently restored to practically its original condition by means of the oxy-acetylene process. When it is considered that new castings would have cost about $5500 and that the actual cost of repairing by welding methods amounted to only ⅓ as much, it is not surprising that the contractor decided to repair instead of to replace, especially in view of the still more important fact that repairing enabled him to get the dredge back into service with only a few days' delay, whereas replacement meant a delay of from 10 to 12 weeks.

BUILDING UP WORN SURFACES OF SAND SUCKER WITH AID OF OXWELD OXY-ACETYLENE BLOWPIPE

The pump chamber of the sand sucker illustrated was 14 ft. in outside diameter, and consisted of two steel castings having a total weight of seven tons. The abrasion had been so severe it was necessary to rebuild both side walls of the pump chamber for a distance of 8 in. from the inner circumference. The thickness of the added metal varied from 1½ to 2½ in. In addition, a new section about 14 by 18 in. in area and approximately 3½ in. in thickness had to be melted into the throat of the casting.

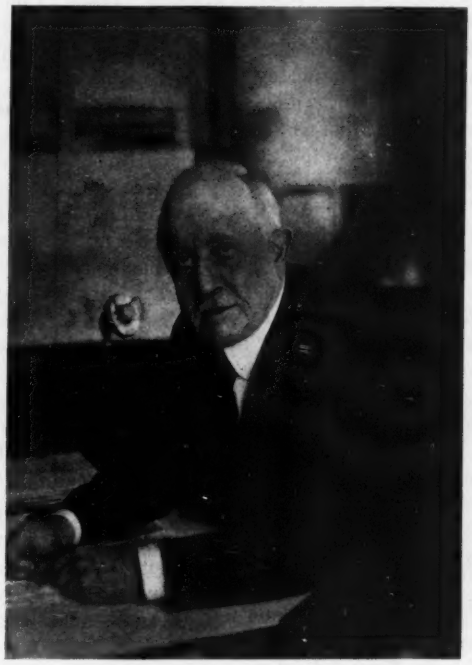
In order to insure holding the two halves of the chamber in alinement during preheating and welding they were bolted together and the heavy outer reinforced sections of the castings were not heated, as this would have produced internal strains, either breaking the castings or shearing the bolts that held them together. Preheating by means of charcoal was applied locally for a distance of about 14 in. in from the edges of the flanges, each preheat extending for a distance of 3 ft. around the inner circumference.

The total weight of steel added to the castings by welding amounted to 1264 lb. The operators, each using an Oxweld blowpipe fitted with No. 15 welding head, worked in pairs. As the heat in the small enclosure where the men worked was intense, it was necessary to hold several welders in reserve and to work on the relay plan, each welding shift extending for a period of 20 min. Six days were required to complete the work.

WILLIAM L. SAUNDERS

ENGINEER AND INVENTOR, AUTHOR, TRAVELER, POPULAR EXECUTIVE, PUBLIC SERVANT, AND, ABOVE ALL — A MAN. BY CHARLES AUSTIN HIRSCHBERG

HISTORY repeats itself in individuals as well as in world events. The remarkable persistence, "go-ahead" determination, ability to overcome obstacles, and creative genius of his ancestor, who, as a member of that sturdy band of men forming the historical Jamestown Expedition, braved the dangers of an unknown land and established the earliest Virginia Settlement (1607) is reflected in the remarkable career of William Lawrence Saunders, known not alone in his own country, but by the world at large for the things he has done to benefit mankind.



Possessing the imagination to conceive, the understanding to direct, and the hand to execute, he has, from the time of his graduation, as a member of the famous Centennial Class of the University of Pennsylvania (1876), been actively identified with some of the world's greatest engineering undertakings, either in directing their execution or in the development of the implements and methods for carrying them on.

Early in life he exhibited a leaning toward the science of engineering and mechanics. He first practised as a civil engineer in 1878 in charge of hydrographic work, the intervening time between graduation and this undertaking being devoted to special newspaper work for Philadelphia papers and as correspondent at the Centennial Exhibition for a number of Southern newspapers. He made two balloon ascensions with Samuel A. King, the famous aeronaut, at the exhibition grounds. On one of these ascensions the balloon reached the height of three and a half miles and remained in the air all night, a remarkable feat at that time.

The years 1879-1881 found Mr. Saunders acting in the capacity of engineer for the National Storage Co. at Communipaw, N. J. He made a series of soundings in New York Bay preliminary to the erection of the National Docks on the New Jersey water front. He also had charge of the construction of piers, warehouses, docks and the ship channel, from the main New York Channel to Black Tom Island on the New Jersey Shore.

It was about this time that his inventive ability first displayed itself. While cutting the ship channel a ledge of hard rock overlaid with gravel and hardpan was encountered. This required drilling and blasting under water, a difficult operation at that time with the implements available. To overcome the difficulties presented, Mr. Saunders made a number of personal experiments in a diving suit, which led to the invention and patenting of appliances for subaqueous drilling, which are still in fashion today and generally used.

He also invented and patented a system of pumping liquids by compressed air, used by municipalities and power plants for water supply, and in the oil fields for obtaining the oil from the bowels of the earth. The Radialaxe system of coal mining is another invention of his fertile brain, as well as innovations covering the drilling and quarrying of rock. These inventions, along with others, called out improvements in air compressor design and the development of a long list of pneumatic machinery used in practically every industry.

Most of these contributions to the mechanical arts were made after he became identified with the Ingersoll-Rock Drill Co. (1881) in the capacity of engineer. This began a life-long association, now 38 yr., which was to lead him through successive stages to the topmost rung of the ladder in the counsels of a large and important business. He was the first president of the Ingersoll-Rand Co., and is today chairman of the Board. He is president of the Ingersoll-Sargent Drill Co. and a director of the A. S. Cameron Steam Pump Works.

While still at college he showed ability as a writer, was editor-in-chief of the "University Magazine," and was elected class poet. This early dilection has remained with him throughout his life, and we find he is the author and co-author of a number of engineering books, scientific articles and papers on national and international

topics. His work has brought him in contact not only with men of renown within his own immediate business sphere, but also with those high in the counsels of the nation. He is an admirer and warm personal friend of President Woodrow Wilson. During the late national emergency—the World War—in his capacity as Chairman of the Naval Consulting Board, of which Thomas A. Edison was President, his counsels served the country well. He stood as close to Secretary Daniels of the United States Navy as perhaps anyone.

As a lecturer and toastmaster he is well known, being noted for his ready wit, a wide knowledge of all subjects, entertaining and enlightening. He adorns whatever subject he either speaks or writes upon by the most splendid eloquence. As a business executive he is pre-eminently successful, having been largely responsible for the upbuilding of the Ingersoll-Rand Co.'s business from its small beginning to its present position.

Pressed for a statement as to what he attributed this success, Mr. Saunders modestly parried the question by laying down the following rules for success in life, which, it is to be noted, define success not merely in a materially commercial sense, but from the broad human standpoint.

"Always bear this in mind: 'Let him that thinketh he standeth take heed lest he fall.'"

"No one can live in the world without the helping hand of his associates; never forget to hold that hand for all time."

"Try to pick out good men and then back them to the limit by putting responsibilities upon them."

"To remove mountains, we should begin on grains of sand."

"If you can't do the best thing, you should be glad to do the next best."

"There are greater things in the world than money."

"Work till it hurts."

Mr. Saunders at the age of 62 is still a young man in vigor of mind and body, the result of right living and right thinking.

He is the imitator of no one. The things he has done and is still doing all bespeak the work of a master mind. A firm believer in the power of publicity for good, when applied in a meritorious cause, he prides himself on the fact that in his earlier association with the company he carried on this important work along with a multitude of other duties. He always looks upon things from the standpoint of the man; he believes that the man makes the job, not the job the man, or, as he characteristically expresses it, "The value of every job is in the value of the man." This well-founded belief has made him a keen student and judge of men generally, and as a result he has been able to surround himself with men of ability, thereby enhancing his own success.

He is an inspiration to all with whom he comes in contact, and is noted for his just yet kindly decisions. It has been said of him "That when satisfied the cause is just, he will hazard all, wherever it may lead." A firm believer in humankind, he always sees the good in everyone.

Mr. Saunders, previous to the World War, was an extensive traveler, accompanying a number of scientific expeditions, and his contributions to engineering literature are based upon first-hand investigations.

Following is a brief sketch of his life and the things he has done. It evidences the confidence displayed in him by all with whom he has come in contact, and forms a true expression of the "Value of the man."

He was born November 1, 1856, at Columbus, Ga., the son of William Trebell Saunders, D. D., and Eliza Morton Saunders. He received the degree of Bachelor of Science, University of Pennsylvania, in 1876, and of Doctor of Science, 1911. Mr. Saunders is now a director of the Latin American Public Works Corp., formerly president and director Muhlenberg Hospital of Plainfield, N. J.; director American Manufacturers Export Association, director Federal Reserve Bank of New York. He is a member of the District Committee on Capital Issues of the Federal Reserve Board, New York Chamber of Commerce, U. S. Chamber of Commerce, New York Foreign Trade Council, National Civic Federation (Chairman of the New York Welfare Committee), National Democratic Club, Executive Committee, League to Enforce Peace, and chairman Nicaragua Permanent Pan-American International High Commission. He was appointed by President Wilson as a member of the New Jersey Harbor Commission, and is associated with the New Jersey Board of Commerce and Navigation. He was nominated by the American Institute of Mining Engineers and appointed by the Secretary of the Navy as a member of the Naval Consulting Board of the United States and served as chairman. He was also a member of the Advisory Board, United States Fuel Administration for New Jersey. Formerly a member of the New Jersey State Democratic Committee, he was also President Wilson's personal representative from New Jersey on the National Campaign Committee in 1916. He was twice elected mayor of N. Plainfield, N. J.

Mr. Saunders is a past president and director, American Institute of Mining and Metallurgical Engineers, and a director, formerly president, Machinery Club; also director, India House. He is also associated with the University of Pennsylvania Club of New York (President and member of the Council), Aero Club, Engineers' Club, University Club, American Society of Civil Engineers, American Society of Mechanical Engineers, Mining and Metallurigcal Society of America, American Iron and Steel Institute, United Engineering Society (trustee), American Academy of Political and Social Science, Philadelphia, the Academy of Political Science in the City of New York, and of the American Geographical Society.

He is editor of the Compressed Air Magazine, author of "Compressed Air Information," "Compressed Air Production," co-author of "The Subways and Tunnels of New York" and "Rock Drilling." Among his numerous other publications are: "Compressed Air, Its Production, Transmission and Use," "A Practical Consideration of Compressed Air," "Quarrying by the Channeling Process," "The History of the Rock Drill," "Rock Drilling Economics," "Tunnel Driving in the Alps," "Right and Strength in Equal Suffrage, "Reveries of a Business Man," "Business and Politics and the Anti-Trust Laws," "Government Regulation of Commerce as Affecting Foreign Trade," and "Compressed Air in the Arts and Industries" for the International Engineering Congress, San Francisco, 1915.

Converting a Steam Plant To Stand-by Operation*

ENUMERATION OF PROBLEMS ENCOUNTERED FOLLOWING A TIE-IN WITH TRANSMISSION SERVICE. BY L. M. KLAUBER

THE SAN DIEGO Consolidated Gas & Electric Co. is interconnected to the system of the Southern California Edison Co. by a 60-kv. 50-cycle line 30 mi. long, from Katella Substation to San Juan Capistrano, and a 70 kv. 60-cycle line, 76 mi. long, from Capistrano to San Diego. These two lines are connected through a 6250-kv.a. frequency changer set at Capistrano. At the San Diego end the step-down transformer bank is rated at 6000 kv.a., 66-12 kv. Energy was formerly steam-generated at San Diego at 2400 v., the close-in distribution system being fed directly at this voltage, while the surrounding territory is furnished with energy at 11 kv. The 2400-v. busses are connected to the 11-kv. busses through three banks of transformers, totaling 6000 kv.a. Thus it will be seen that there are two transformations interposed between the local generators and the transmission line. The steam equipment at San Diego includes 6194 hp. of water-tube boilers; and turbines and engines totaling 11,750 kw., of which the more modern units are one 2000-kw. and two 4000-kw. horizontal sets.

As a stand-by steam plant is operated primarily for the betterment of service, either as to continuity or regulation, there is more latitude in the schedule of operations than exists in a plant producing energy. Necessarily, this schedule will be determined by the quality of service received from the transmission line and the degree to which that service must be improved before it is passed on to the customer. Having once determined upon a schedule of operations, it remains to secure the result as safely and economically as possible.

TIMES AND CONDITIONS OF HEAVY LOAD

PRIOR to the time of the completion of the tie-in with the Edison Company practically all of the energy used by the San Diego Company was steam generated in the San Diego plant. Subsequent to the tie-in, the load factor requirements of the contract covering the purchase of energy and the limited capacity of the connecting frequency changer necessitated the generation of about 15 per cent of the total energy required by the steam. The bulk of this 15 per cent is required over the evening peak; however, during the dry season when irrigation load is on, some energy must be produced throughout the entire day. Thus it is necessary to operate a turbine for energy-producing purposes each evening, and for a part of the year, during the day load. The first problem in connection with stand-by operation was to decide as to the dependence to be placed on transmission service, and whether sufficient generators should be floated at all times to enable the entire load to be picked up immediately. After due consideration and the development of experience with the hitherto untried transmission line, the following schedule was adopted:

A 4000-kw. turbine capable of carrying 5200 kw. is floated daily except between midnight and 6:30 a. m. This permits the immediate assumption of from 85 per cent to 100 per cent of the day load and from 60 to 70 per cent of the night load. On Sundays and holidays no machine is floated until 11:00 a. m. At times of storms or other uncertain line conditions, sufficient units are floated to carry the entire load. The location of the frequency changer at Capistrano gives the San Diego Company an independent voltage control which betters the ordinary transmission service and renders it unnecessary to float a turbine strictly for regulating purposes. However, it is of course true that it is often desirable, entirely aside from consideration of continuity, to float a turbine in order to reduce line loss.

FAILURE WHEN TURBINE IS DEAD

ON THE WHOLE, the service secured from this schedule of operations is satisfactory, although not so good as that which was rendered before the tie-in. After midnight, when the floating of a turbine appears to be unjustified, either for continuity of service, regulation or reduction of line loss, it is necessary to start a turbine from rest to pick up the load in case of failure. By means of close co-operation in the operating force and the installation of the several operating methods described below, we have found that we can put a dead 4000-kw. turbine on the line and pick up full load within 3 min. after transmission service has failed. This is accomplished by two men in the engine room, the operating engineer and the assistant engineer.

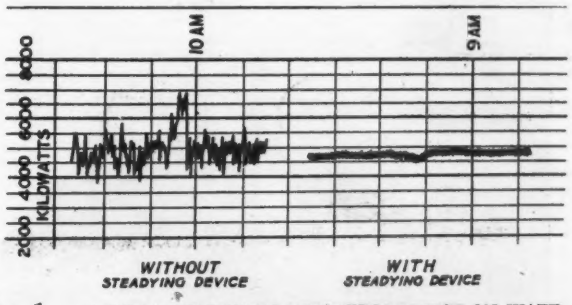


FIG. 1. EFFECT OF GOVERNOR STEADYING DEVICE ON WATTMETER CHART

STEADYING THE TURBINE GOVERNORS

SOME of the mechanical problems of interconnection developed immediately the two systems were tied together. As our operating schedule requires that the transmission line be loaded to the capacity of the frequency changer at all times when the total load exceeds this quantity, it is desired to regulate the load on the turbines very carefully and for long periods over the day load it is necessary that the turbine operate at but a fraction of its rating. No difficulty was experienced in synchronizing and tying the two systems together, but when an attempt was made to follow the schedule above outlined, it was found impossible to maintain a proper load division, even with the constant attention

* Abstract of paper read before the Pacific Coast Section, N.E.L.A.

of the operator. The turbine governors appeared oversensitive and load sweeps of from 1000 to 2000 kw. occurred continuously at intervals of less than one miute (Fig. 1). It was seen at once that some steadying devices would have to be applied to the turbine governors. The first device experimented with consisted of a beam fastened to the turbine frame at the lower end and clamped at the upper end to the vertical rod connecting the governor lever to the floating lever of the pilot valve. The clamp, faced with leather, was arranged to slip on the connecting rod, the friction of the grip being regulated by adjusting screws. By this means the small movements of the governor were prevented and the load on the turbine steadied. However, this device had the serious disadvantage that load could not be regulated from the switchboard gallery, for if the electrical governor control were operated too large a movement was required before slippage occurred. Consequently, it was necessary for the man on the floor to manipulate the load on signal from the operator—a very objectionable condition. This difficulty was entirely obviated by the invention by one of our operating engineers of the load

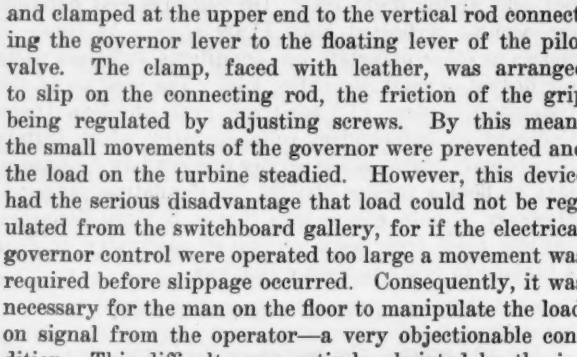


FIG. 2. GOVERNOR STEADYING DEVICE

steadying device shown in Fig. 2. This consists essentially of a rigidly trussed beam which parallels the governor beam, the pivot point being anchored to the frame, one end being connected to the base of the synchronizing spring, and the other end being attached to a leather-faced clamp which grips the rod connecting the governor beam to the floating lever. The clamp is fitted with proper adjusting screw for varying the friction and also with a release so that it may be quickly disconnected by a half turn of the adjusting screw. This device has given excellent results. The turbine load is easily adjusted by quantities as low as 50 kw. with the ordinary governor control from the gallery. The load fluctuations are reduced to a minimum, as shown in Fig. 1. The device does not prevent the turbine from picking up load instantly when the transmission line goes off, and there appears to be no dangerous tendency to overspeed when load is unexpectedly dropped.

Cooling the Blading

In connection with floating turbines it was of course necessary to provide sufficient steam to cool the blading. In order to determine what quantity would be required and to secure safety of operation, a recording thermometer was installed on each turbine, the temperature element being inserted in the last diaphragm. The rules of operation require that sufficient steam be admitted to keep the temperature at this point below 250 deg. F. at all times. It was found that on two of the turbines sufficient steam leaked through the controlling valves and packing to keep the temperature below this point. On the third turbine it was necessary to bypass the controlling valves. A ¼-in. pipe was first tried, but this does not pass enough steam to keep the blading below the required temperature when floated for long periods, and it is therefore necessary to admit steam at intervals through the controlling valves. This is done by operation of the governor control, the turbine being operated with a slight load for about half an hour, which quickly brings the temperature down. It is probable that the size of the bypass will be increased so that the machine may be floated indefinitely. It might be noted that the leakage of a small quantity of steam past the control valves appears to be a benefit in a stand-by plant, as it enables the starting of a dead turbine quickly with avoidance of expansion difficulties that might otherwise occur.

Schedule of Operation

The schedule of operation of turbine auxiliaries in a stand-by plant requires some deviation from the practices of normal operation. As no storage battery was available, it was decided to keep a steam-driven exciter in operation at all times, not only for excitation in case of transmission line failure, but also to furnish emergency plant lighting and energy for the switchboard control circuits. As to the condenser equipment, it appears best to operate with the best possible vacuum on the turbine when floating. Naturally, less circulating water is required at such times, but determinations of the energy required for the operation of the circulating pump with discharge partially closed did not appear to warrant throttling, especially as these pumps are not equipped with electrically operated valves. However, one economy was effected by cross-connecting the circulating pumps of the three turbines. When all turbines are shut down, the steam driven circulating pump on the 2000-kw. turbine is operated to circulate water through the condenser of the most economical of the 4000-kw. turbines, which is equipped with a motor-driven circulating pump. Thus, by means of this small pump we are aided in getting a quick start on the large turbine, as the small pump not only keeps the circulating system primed, but furnishes sufficient water so that it is unnecessary to start the pump belonging to the turbine until the unit is brought to speed and carries full load. When all turbines are shut down, no auxiliaries are kept running but the exciter and the small circulating pump, and all are started in the three minutes within which the turbine is put on the line.

Some difficulty was experienced with the motor-driven circulating pump of the larger turbine, as the low-voltage release caused it to drop out whenever the transmission line went off, due to the fluctuation in the voltage before the turbine picked up the load. This was corrected by the installation of a home-made oil dash pot on the low voltage release, which may be recommended as a cure for similar difficulties on important motor installations. The low voltage release will not

hold in long enough to cause the motor to be injured if the energy is off more than momentarily.

These turbines are equipped with one of the usual forms of boiler room indicators which show by rows of colored lamps the number of valves open on each turbine. It was necessary to modify slightly this device so that the first lamp would be lighted, not at the opening of the first valve, but whenever a turbine is operating, so that it thus indicates the floating condition. In connection with the floating of turbines, non-reversing devices were placed on all of the generator watt-hour meters, so that the current consumed by these generators when motoring would not be considered as a deduction from current generated, but would rather be observed in the unaccounted for distribution losses, which would seem to be proper accounting.

Problems of the Boiler Room

The boiler room offered some interesting problems in the quick generation of steam and in stand-by economies. As this plant furnishes steam to an adjacent gas plant and ice plant (although in a far less quantity), the problem was somewhat different from that of the ordinary stand-by plant. Klaxon signals operated from the switchboard gallery were at once installed in the boiler room and at various points in the gas plant at which steam is consumed. By means of one long blast on this signal system, notification is given of the failure of the transmission line and the gas plant steam consumption is instantly reduced to a minimum, which aids materially in securing sufficient steam to pick up load. To aid in starting additional boilers quickly, gas pilots were introduced and proved quite successful. In other boilers which ordinarily burn tar over a lampblack fire (which runs the boiler far under capacity), arrangements were made to introduce oil into the tar burners, this being atomized with compressed air, as it is difficult to get sufficient air through a lampblack fuel bed to burn oil over it. This made it possible to secure full load from a pair of boilers which under normal operation operate at barely one-third of rating.

It was early seen that quick assumption of load transmission line failure was a more difficult problem in the boiler room than in the turbine room, and it was therefore decided to install the Merit Automatic Stoker System on six of the boilers , totaling 3280 hp. This system has been installed but a short time, but thus far has been successful both in improving the stand-by economy of the plant and the rapidity of steam generation. In order to compensate for pressure drop in the steam lines between boilers and turbines, the control pressure is tapped at the turbine, which gives a much closer regulation. At present with two boilers operating at about one-third load on lampblack, furnishing steam for the gas plant, and enough boilers on pilot fire to carry full load, full load will be picked up on a turbine practically instantly, and with only a momentary drop of 5 lb. in steam pressure on the recording pressure chart.

Before the Merit Stoker System was installed, considerable judgment was necessary on the part of operators in bringing in a second turbine, since, as the capacity to deliver steam quickly was the limiting factor, if a second turbine were brought in too quickly, the steam taken by this machine and its auxiliaries at starting would reduce the load which the running turbine might carry.

Regulation of Water Supply

After the tie-in it was necessary to give consideration to the question of fresh water economy. Naturally, the balance which had existed under pure steam operation was modified; the amount of fresh water required for make-up water was materially reduced and at the same time the addition of water-cooled step-down transformers added to the quantity required for cooling purposes. In consequence there was a surplus of fresh water in spite of efforts made to cut to a minimum the amount going to the transformers and the turbine bearing cooling coils. After an investigation of various schemes, including the installation of a cooling tower, or the procuring of circulating water from an adjacent gas holder tank, it has been decided to circulate salt water through the turbine bearings. This scheme will shortly be placed in operation and it is believed no deleterious results will follow. An automatic pressure valve will be installed so that upon failure of the salt water supply, fresh water will automatically flow into the coils. A salt water cooled oil cooler is likewise to be installed on one of the turbines to still further reduce the water required in the bearings. If this is successful in conserving oil and water by a reduction in the bearing temperature, the other turbines will be similarly equipped.

Some difficulty was experienced in maintaining a proper balance in the exhaust steam for feed water heating under the new conditions of operation, and it has been necessary to exercise great care in returning all of the exhaust steam available for this purpose to secure the desired result.

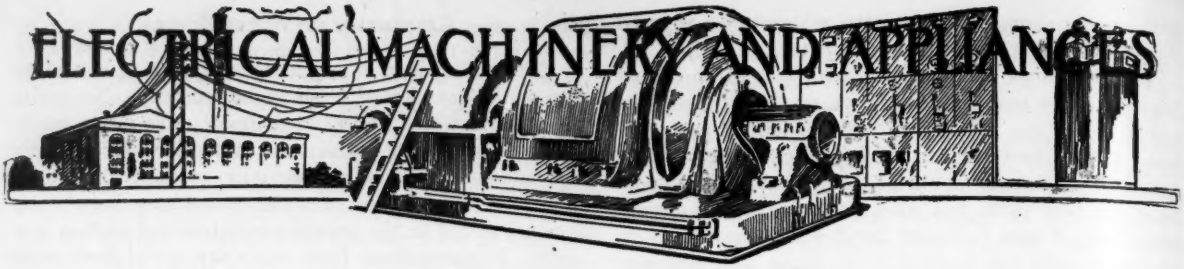
Plant Efficiency Raised

In conclusion it may be noted that the installation of the various methods and devices described has not only improved continuity of service, but has raised the plant efficiency (when on stand-by service) from about 80 to 105 kw.-hr. per barrel of oil. The efficiency of this plant before the tie-in when generating all of the energy required by the company was from 212 to 220 kw.-hr. per barrel of oil depending on the load factor.

Trouble With the Foundry Fan

By Mark Meredith

THERE WAS a foundry fan used in connection with a sand-blasting apparatus, which, owing to the high pressure—31 lb. per sq. in.—required to lift the shot, ran at a very high speed. It had been running very indifferently some time and made a great noise, so it was decided to fit new bearings. Noticing the spades on the vane were somewhat knocked about, it appeared to be out of balance. The spades were very much worn, and two of them were badly out of shape. After the new bearings were fitted to the spindle and it had been trued up, it invariably ran hot, making a great noise, thus indicating out of balance. Knowing that a fan vane may be in perfect static balance and not be in what is known as a running balance, owing to the irregular shape of the spades, a new vane was filled. This was supplied, the bent blades were straightened, and all the trouble was obviated.



Feeder Regulators---II

THEORY OF OPERATION AND DETAILS OF CONSTRUCTION OF THE INDUCTION TYPE MACHINE. BY V. E. JOHNSON

THE voltage ratio of a transformer dependes on, (1) the ratio of primary turns to secondary turns, and (2) the ratio of primary flux to secondary flux.

In the switch type regulator, the ratio is changed by varying the number of secondary turns. In the single-phase induction regulator the ratio of transformation is changed by varying the amount of flux which interlinks the primary and secondary coils. Instead of having the position of the primary coils fixed as regards the secondary, their relative positions may be changed so as to vary the ratio in a manner to be described later.

In Fig. 12 is shown the essential parts of a typical induction regulator. The tank has the secondary windings shown in place. The primary winding resembles in mechanical construction an ordinary armature. To

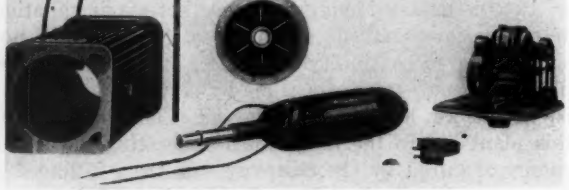


FIG. 12. ESSENTIAL PARTS OF A TYPICAL INDUCTION REGULATOR

the right of the armature is shown the gear which controls the movement of the rotor in response to the action of the control motor and auxiliary mechanism shown at the extreme right.

In Fig. 13 is a diagram which shows how the primary and secondary windings in a single phase regulator are arranged. The diagram shows but one turn in each coil, but in actual practice the coils are made up of a great many turns. The secondary current (main line current) flows from the generator, down through the paper in the left top slot across the bottom to the lower left-hand slot and from there up through the paper. From here it goes to the right-hand coil of the secondary and to the feeder. The primary rotor coils also go as indicated by the solid and dotted lines. It will readily be seen that in the position indicated the axes of the primary and secondary coils coincide—and the coil sides lie in practically parallel planes.

Bearing in mind that the secondary currents of a transformer flow in such a direction as to produce a flux which at any instant opposes the primary flux let us determine in Fig. 13 as shown whether the 230 v. generated in the secondary would be added to or subtracted from the generator voltage. It will be noticed that the primary and secondary coils in the position shown are wound in the same direction. Assume that at a given instant the current flows "out" from the generator on the lower wire—from our "right-hand" side it follows that the primary flux is from right to left. The fundamental transformer rule just quoted would then indicate that the secondary flux must flow from

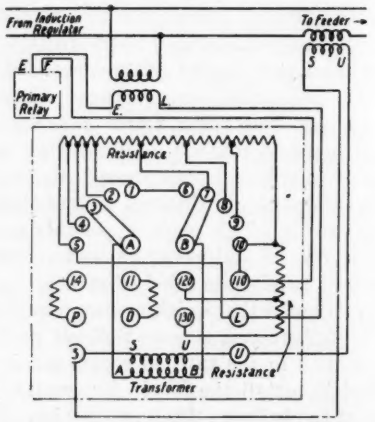


FIG. 13. DIAGRAM OF CONNECTIONS OF A SINGLE-PHASE INDUCTION REGULATOR

left to right (i. e. in opposition to primary flux) and this can be possible only if the secondary current flows or tends to flow in "toward" the generator along the bottom wire. In other words, the 230 v. are subtracted from the 2300 v. on the generator side, leaving 2170 v. as the feeder.

By rotating the revolving member through 180 deg. the secondary voltage will again be a maximum of 230 v. but will in this case be boosting.

Consider now the condition when the primary coils stand at right angles to the planes of the secondary coils. It is evident that none of the primary flux links with the secondary coils—and as a result, the secondary coils generate no voltage—and the regulator is in "neutral" position. By turning the rotor so that its coils

occupy various intermediate positions, it is evident that a corresponding "boosting" or "bucking" effect can be produced.

It will be well to note here that the secondary voltage is always in phase with the primary flux current (or in opposition) and that turning the rotor changes the value of the secondary voltage but not its phase relations with regard to the line voltage. The induced voltage is proportional to the cosine of the angle which the axes of the primary coils makes with the axes of the secondary coils, but is always added directly to or subtracted directly from the primary voltage.

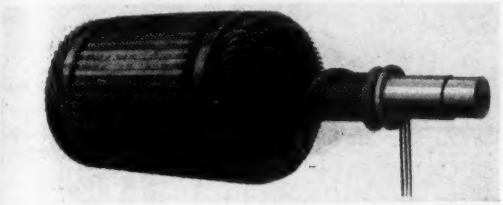


FIG. 14. ROTOR OF A 3-PHASE INDUCTION REGULATOR

Referring again to Fig. 13, it will be seen that on the movable member is placed a pair of short-circuit coils. When the rotor is in the position indicated, that is, maximum buck, or when it is in the maximum boost position, none of the primary flux links with these short-circuited coils, no voltage is generated in them, no current flows, and as far as the operation of the regulator is concerned they might as well be removed. In the neutral position, however, these short-circuited coils play a very important part.

If, in the transformer as shown, the primary be disconnected, there will be no primary flux generated, and the secondary will provide magnetism proportional to the load flowing through it, that is, the load current

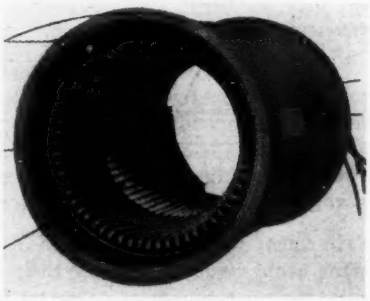


FIG. 15. STATOR OF A 3-PHASE INDUCTION REGULATOR

becomes in a sense magnetizing current. If the connected load be very large—approaching a short circuit—the result would be practically the impressing of 2300 v. across a 230-v. coil. With loads even considerably less than this value, the current is still large enough to induce extremely high voltages in the primary, and produce a large reactive drop at the secondary terminals. In fact, it would be possible to absorb a great proportion of the total voltage in overcoming this reactive drop. Furthermore, the current taken by the choke coil would be lagging 90 per cent behind the generator voltage and would produce low power factor, with its attendant troubles.

Applying a short circuit across the primary transformer coils after disconnection from the line would reduce the choke coil effect to a negligible value.

Considering now the feeder regulator with its primary coils in the neutral position; it is obvious that as the primary flux does not interlink with the secondary coils, it does not oppose the secondary magnetism, and might as far as the demagnetizing action is concerned be cut out entirely. The tendency then would be for a high reactive drop through the secondary coils—resulting in low voltage and poor power factor. To obviate this difficulty, thus, the rotor has on it the short-circuited coils shown. In the neutral position these

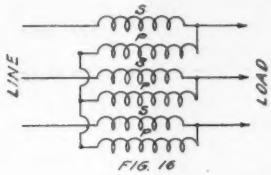


FIG. 16

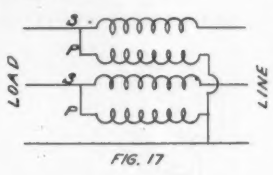


FIG. 17

FIG. 16. INTERNAL CONNECTIONS OF A 3-PHASE INDUCTION REGULATOR

FIG. 17. CONNECTION DIAGRAM OF 3-PHASE CIRCUIT EMPLOYING TWO REGULATORS

coils link directly with the secondary flux, and have set up in them a short circuit current, which demagnetizes the secondary coil and reduces the reactive drop to nearly zero. Thus at the two limiting positions—namely, maximum boost (or buck) and neutral, the electric and magnetic relations correspond closely to those in the static transformer to "connected" primary and "open" primary respectively.

For intermediate positions the conditions compare with those existing in a static transformer where a resistance is gradually introduced in the transformer primary circuit. To compare exactly for the decreased primary flux, it would be necessary to short-circuit a third coil, gradually linking the secondary flux so as

FIG. 18

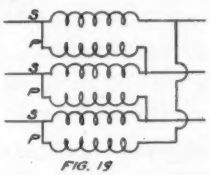


FIG. 19

FIG. 20

FIG. 18. VECTOR DIAGRAM OF VOLTAGES IN ARRANGEMENT SHOWN IN FIG. 17

FIG. 19. CONNECTION DIAGRAM OF 3-PHASE CIRCUIT EMPLOYING THREE SINGLE-PHASE REGULATORS

FIG. 20. VECTOR DIAGRAM OF VOLTAGE IN ARRANGEMENT SHOWN IN FIG. 19

always to keep the secondary reactance low. Similarly in the induction regulator, as the primary coils are gradually turned toward neutral, the short-circuited turns are becoming more and more active (thus overcoming the tendency for the secondary reactive drop to increase). In any position, limiting or intermediate, the flux due to the short circuit current in these coils always combines with the primary flux so as to

reduce the reactive voltage drop or choking effect of the secondary to a minimum.

The Polyphase Regulator

In Figs. 14 and 15 are shown respectively the rotor (primary) and stator (secondary) of a 3-phase induction regulator. These very closely resemble the rotor and stator of a wound rotor induction motor. The majority of the polyphase regulators have a four-pole winding, and have a winding diagram exactly the same as a four-pole three-phase motor. The rotor or primary is connected, while the secondary has both ends of each phase brought out and connected in series with the line.

In Fig. 16 is shown the internal connections.

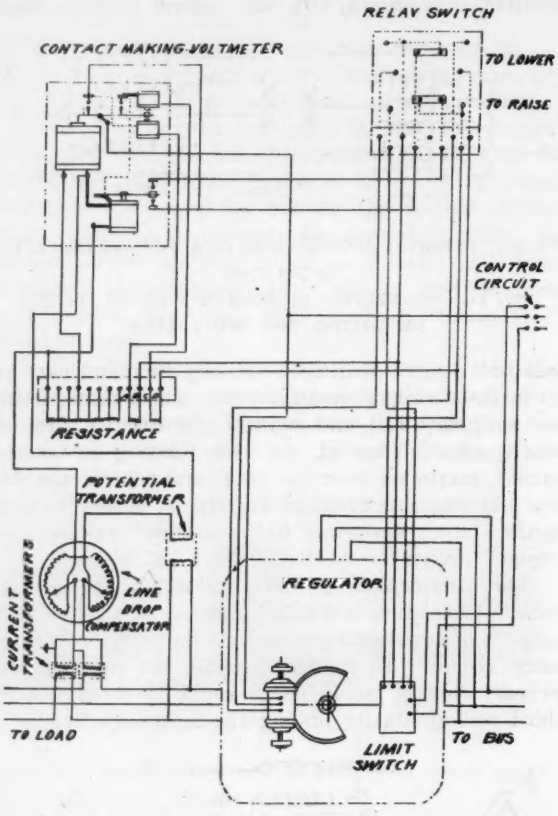


FIG. 22. DIAGRAM OF CONNECTIONS FOR A THREE-PHASE REGULATOR

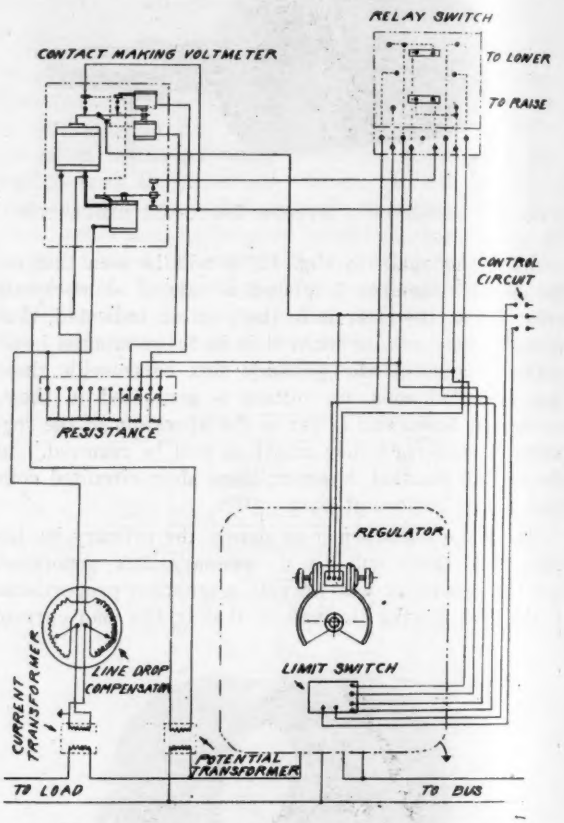


FIG. 21. DIAGRAM OF COMPLETE CONNECTIONS FOR A SINGLE-PHASE INDUCTION REGULATOR

The action of a polyphase regulator differs from that of a single-phase machine, but it produces the same result.

In both the induction and switch type regulators the secondary voltage is always in phase with (or in opposition to) the generator voltage, and is directly added to (or subtracted from) it.

In the polyphase regulator, however, the ratio of transformation does not change, but regulation is secured by varying the angle between the generator voltages and the regulator secondary voltages. Any three phase magnetic circuit has induced in it when excited from a polyphase source of current a rotating field of constant value. In a four pole regulator this field would make 1800 r.p.m. and the magnetic poles would revolve just as truly as if they were magnetized from a d. c. source and the iron itself turned. This revolving field cuts the conductors of the stator just as the rotor magnetism in an alternator cuts the stator coils; a voltage is generated in each secondary phase which is proportioned, among other things, to the number of secondary turns, the flux density and the field speed. These three are constant, therefore the secondary voltages induced are constant, regardless of what position the rotor is placed in mechanically. Moving the rotor would be analogous to rotating the stator of a generator in a plane parallel or coinciding with the plane of the rotor. The stator voltage would be constant, no matter what position the stator voltage was in. Following this analogy further, it can readily be seen that if the rotor was in some way kept in perfect phase alinement with a given source of power, the stator currents could be made to vary their phase relationships with the same source of power at any desired angle by merely turning the stator in its cradle. If, then, we connected a given phase of the power circuit in series with a corresponding phase on the generator, the vector sum of these voltages could be varied as desired merely by moving the adjustable stator in its cradle.

The movement of the polyphase regulator rotor merely changes the phase angle between the stator and rotor voltages. If the "north" poles (referring to instantaneous polarities) of the rotor is directly opposite the stator pole of the same phase—there is no phase displacement, and the secondary voltage is directly added to (or subtracted from) the primary voltage. If the rotor be turned so that the "south" pole be opposite the

same stator pole—the secondary voltage will be subtracted directly from the primary voltage. At intermediate points the total voltage will be the vector sum of the primary and secondary.

There is no position in a polyphase regulator which corresponds to the neutral position of a single-phase regulator as regards reactive drop. For that reason, no short-circuiting turns are necessary.

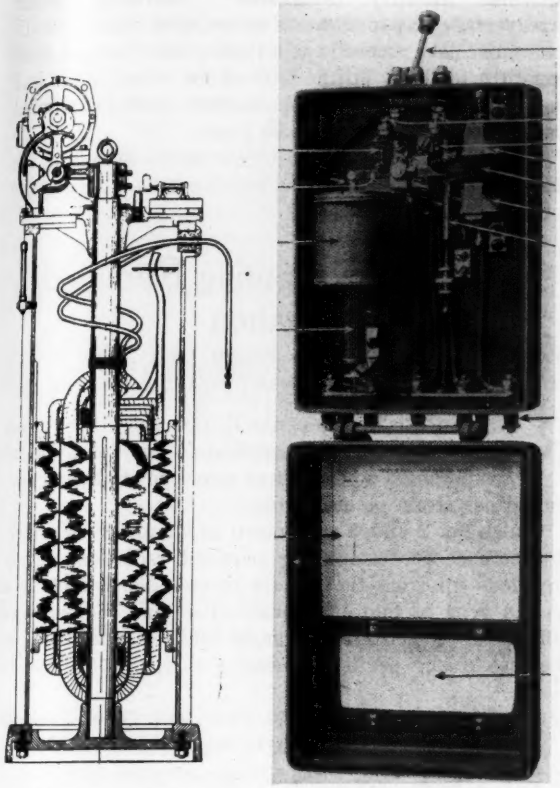


FIG. 23. CROSS SECTION OF A SINGLE-PHASE REGULATOR
FIG. 24. A TYPICAL PRIMARY RELAY OR CONTACT-MAKING VOLTMETER

To allow for drop of voltage in regulator windings when load is applied, it is customary to design regulators so that they give on no load about 10 per cent higher secondary voltage than the regulator name plate would indicate.

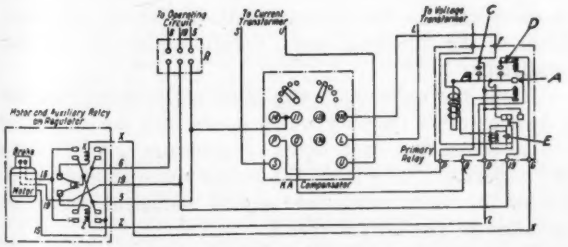


FIG. 25. DIAGRAM OF CONNECTIONS OF CONTACT-MAKING RELAY SHOWN IN FIG. 24.

In Fig. 17 is shown a three phase circuit using two regulators. If these are 10 per cent regulators, the voltage of all three phases will be increased 10 per cent if the regulators are both in the maximum boosting position. This is clear from Fig. 18, which shows the vector relations. If the relays on the two regulators operate simultaneously, the action would be similar to that of a three phase regulator. In actual service this, however, would seldom happen, with the result that there would be some distortion of phase voltages.

In Fig. 19 is shown a three-phase circuit using three single-phase regulators, and in Fig. 20 a vector diagram showing their affect on the voltage triangle. If three 10 per cent regulators are used and they all are at maximum boost simultaneously, the total voltage across phases would be increased more than 10 per cent, as is plainly evident from the vectors. AB is generator voltage, AB^1 is the generator voltage boosted 10 per cent in one phase, while A^1B^1, which is greater than AB^1, is line voltage when three regulators are connected and boosting is 10 per cent on each regulator.

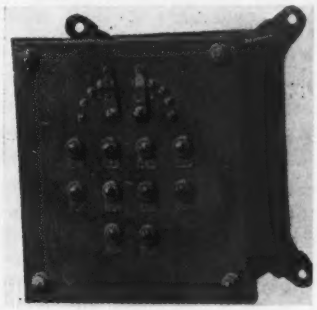


FIG. 26. GENERAL APPEARANCE OF A TYPICAL COMPENSATOR

The tabulation below gives in general the application of the three types of polyphase regulators. For power loads and perfectly balanced lighting loads, or where lighting is unimportant—use one three-phase regulator. For mixed loads—with considerable lighting taken off three-phase feeders—use two one-phase regulators. For lighting loads—with the power in the "minority"—use three-phase regulators.

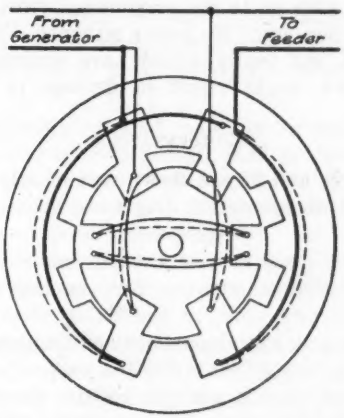


FIG. 27. DIAGRAM OF CONNECTIONS OF COMPENSATOR SHOWN IN FIG. 26

AUTOMATIC CONTROL

THE APPARATUS for automatically controlling induction regulators resembles quite closely that outlined

under step by step regulators. It consists of (a) a primary relay or contact making voltmeter which, under the influence of the voltage to be regulated, makes proper connections of a control circuit to (b) the secondary relay or relay switch. This is nothing more or less than a reversing switch which supplies current to (c) the operating motor and causes it to turn the regulator rotor in the proper direction. This motor is normally at rest, and is energized only when voltage is abnormal. (d) A line drop compensating device which responds to changes in load and automatically causes the regulator to compensate for these.

In Fig. 21 is shown a diagram of complete connection for a single-phase induction regulator, while Fig. 22 shows the conection of a three-phase regulator.

In Fig. 23 is shown the cross section of a single-phase regulator. It will be noted that the secondary punchings are stacked directly in the tank, the latter thus forming the supporting frame. The bottom of the tank is removable, and this facilitates repairs to the secondary coils.

In Fig. 24 is shown a primary relay, or contact-making voltmeter, while in Fig. 25 is shown its diagram of connection. The compounding coils serve to make firm connection between the relay contacts, and to prevent chattering; as soon as the least current flows through either of them they attract the metal armature A and hold the lever B firmly in position. By properly adjusting the compounding coils, it is possible to have these release the lever B when the voltage is normal and of such value as to hold the lever in the middle position.

The no voltage release coil E cuts the contact "out" when the feeder voltage fails. If it were not for this attachment, the regulator would, upon an interruption of power, at once go to the maximum "boost" position and remain there until the power returned. Then, for a short period, the feeder would have abnormally high voltage—which might result in damage to connected apparatus.

Compensators

In Figs. 26 and 27 are shown cuts of a typical compensator and its connection diagrams.

The U. S. Civil Service Commission announces an open competitive examination for associate mechanical engineer, for men only, in the Safety Section of the Bureau of Standards, Department of Commerce, at salaries ranging from $2000 to $2800 a year.

The duties of this position require the services of persons of good address, able to confer with superintendents of shops and capable of making inspections, holding conferences, and addressing audiences.

Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated: Education, training and experience, 60; thesis (to be filed with application), 40.

Applicants must have graduated from a standard high school, or completed a course of study equivalent to that required for such graduation, and have had at least seven years' experience in safety or casualty inspection work. The completion of each year of an engineering course in a college or university of recognized standing will be accepted as equivalent to one year of the required experience (not exceeding four).

Applicants may qualify in any one of the following subjects in which they are experienced, and the thesis required under the second subject must deal with the application of safety devices or other safeguards in the particular industry designated: Elevators, power plants, textile or paper manufacture, steel mills. Applicants must have reached their twenty-fifth but not their forty-fifth birthday on the date of the examination and must submit with their applications there unmounted photographs, taken within two years.

This application is open to all male citizens of the United States who meet the requirements. Apply for Form 2118.

Rules For Computing Required Radiation

Standard Formulas for Steam and Hot Water Radiation by National District Heating Association*

Rule No. 1 is known as the B. t. u. rule for figuring radiation and can be applied to any condition of temperature differences or any type of heating system, either steam or hot water.

Rules No. 2 and 3 are known as simplified or short-cut methods for computing required radiation. They are made up from the factors in rule No. 1 and fit a certain type of building construction and temperature difference. When circumstances make it advisable, in the case of any particular heating company, to have in use a simplified formula, a rule similar to rules No. 2 and 3 can be made up from the factors in rule No. 1 to fit local conditions, with an average type of building construction.

TABLE I. B.T.U. REQUIRED TO HEAT ONE CUBIC FOOT OF SPACE AT VARIOUS TEMPERATURES AND AIR CHANGES

No. Air Changes	B. T. U. 1° Difference	Difference in Temperature Between Rooms and Outside: 50°	60°	70°	80°	85°	90°
½	.01	.50	.60	.70	.80	.85	.90
¾	.015	.75	.90	1.05	1.20	1.27	1.35
1	.02	1.00	1.20	1.40	1.60	1.70	1.80
1½	.03	1.50	1.80	2.10	2.40	2.55	2.70
2	.04	2.00	2.40	2.80	3.20	3.40	3.60
3	.06	3.00	3.60	4.20	4.80	5.10	5.40
4	.08	4.00	4.80	5.60	6.40	6.80	7.20

Any room or space having an opening which may communicate with rooms or space to be heated, whether radiation be installed or not in such rooms or space, must be considered in the measurements for space heated in either of the following ways, depending on the existing conditions:

1. If the unheated space is an active room and has a door or other opening which opens into the adjoining heated space and such doors or openings are left open the majority of the time, the entire space should be included in the measurements and sufficient radiation installed in the heated rooms.

2. If the unheated space is an inactive room and the doors or other openings are to be closed the majority of the time, the space and exposures of the unheated room should not be included in the measurements, but the walls adjoining the unheated and heated space should be

*From a report of the Rules and Regulation Committee, N. D. H. A. These rules were adopted as applying to steam companies and recommended for hot water wherever applicable.

taken as exposed surfaces in the measurements for the heated room. Basements and attics, which are used for storage purposes only, should not be considered as space to be heated.

Following are the three rules referred to above.

RULE No. 1

Since the radiation in any room must emit sufficient heat to compensate for all heat losses from that room and since heat is transmitted by different building materials at different rates, it follows that:

$$\text{Radiation required} = \frac{\text{B. t. u. lost per hr. from room}}{\text{B. t. u. emitted per sq. ft. of radiation per hr.}}$$

$$= \frac{H}{\text{B. t. u. per hr. from radiation}}$$

$$R = \frac{H}{X \text{ (Temperature difference between contents of radiator and room temperature)}}$$

TABLE II. B.T.U. LOSSES PER HOUR THROUGH ONE SQUARE FOOT OF VARIOUS BUILDING MATERIALS WITH VARYING TEMPERATURE DIFFERENCES

	B. T. U. Difference K	Difference in Temperature Between Room and Outside 50°	60°	70°	80°	85°	90
Windows, single glass, full sash area	1.25	62	75	87	100	106	112
Windows, double glass, full sash area	.60	30	36	42	48	51	54
Plate Glass	1.00	50	60	70	80	85	90
Skylight, single glass, full sash area	1.10	55	66	77	88	94	99
Skylight, double glass, full sash area	.60	30	36	42	48	51	54
Wooden door, 1"	.40	20	24	28	32	34	36
Wooden door, 2"	.36	18	22	25	29	31	32
Brick wall, 8½" plain	.37	18	22	26	30	32	33
Brick wall, 13" plain	.29	14	17	20	23	25	26
Brick wall, 17½" plain	.24	12	14	17	19	21	22
Brick wall, 22" plain	.21	10	13	15	17	18	19
Brick wall, 27" plain	.19	9	11	13	15	16	17
Brick wall, furred and plastered, use .7 times non-furred.							
Stone wall, use 1.5 times brick wall.							
Concrete, 2" solid	.78	39	47	55	62	66	70
Concrete, 3" solid	.71	35	43	50	57	60	64
Concrete, 4" solid	.66	33	40	46	53	56	59
Concrete, 6" solid	.56	28	34	39	45	48	50
Frame wall (plaster, lath, stud, clapboard)	.50	25	30	35	40	43	45
Frame wall (plaster, lath, stud, sheating, clapboard)	.28	14	17	20	22	24	25
Frame wall (plaster, lath, stud, sheating, paper, clapboard)	.23	11	14	16	18	20	21
Hollow tile, 2", ½" plaster, both sides	.41	20	25	29	33	35	37
Hollow tile, 4", ½" plaster, both sides	.33	16	20	23	26	28	30
Hollow tile, 6", ½" plaster, both sides	.28	14	17	20	22	24	25
Solid plaster partition, 2"	.60	30	36	42	48	51	54
Solid plaster partition, 3"	.50	25	30	35	40	43	45
Concrete floor on brick arch	.20	10	12	14	16	17	18
Fireproof construction as flooring	.10	5	6	7	8	9	9
Fireproof construction as ceiling	.14	7	8	10	11	12	12
Single wood floor on brick arch	.15	8	9	11	12	13	14
Double wood floor, plaster beneath	.15	8	9	11	12	13	14
Wooden beams planked over, as flooring	.17	9	10	12	14	14	15
Wooden beams planked over, as ceiling	.35	17	21	25	28	30	32
Lath and plaster ceiling, no floor above	.62	31	37	43	50	53	56
Lath and plaster ceiling, floor above	.25	13	15	18	20	21	22
Steel ceiling, with floor above	.35	17	21	25	28	30	32
Single ¾" floor, no plaster beneath	.45	23	27	32	36	38	41
Single ¾" floor, plaster beneath	.26	13	16	18	21	22	23

PERCENTAGE OF INCREASED RADIATION DUE TO HIGH CEILINGS.

Rooms 12 to 14½ ft. from floor to ceiling 3%
Rooms 14½ to 18 ft. from floor to ceiling 6%
Rooms 18 ft. and above from floor to ceiling 10%

The value of X in the following computations is taken as 1.7 B. t. u., which is the coefficient of heat transmission from the type of radiation most generally used. See Table III for coefficients for various types of radiation and pipe coils.

Gravity straight steam systems having from 1 to 3 lb. pressure;

$$R = \frac{H}{1.7\ (220\text{-}70)} = \frac{H}{255}.$$

$$\text{Safe Value} = \frac{H}{250}.$$

Vapor systems with individual traps on the return end of each radiation:

$$R = \frac{H}{1.7\ (212\text{-}70)} \text{ for steam at atmospheric pressure} = \frac{H}{241}.$$

$$\text{Safe Value} = \frac{H}{240}.$$

Atmospheric systems with open return and excess radiation for cooling surface:

$$R = \frac{H}{1.7\ (212\text{-}70) \div 1.20} = \frac{H}{200}.$$

Hot water systems having an average of 170 deg. F. water:

$$R = \frac{H}{1.7\ (170\text{-}70)} = \frac{H}{170}. \qquad \text{Safe Value} = \frac{H}{165}.$$

Percentage by which the heat losses given in Table II. are increased if the exposure is other than southern, is 10 to 15 per cent for N. E. or N. W. rooms, and 5 to 10 per cent for E. or W. rooms.

TABLE III. VALUE OF X, COEFFICIENT OF HEAT TRANSMISSION FROM RADIATORS

Height of Radiators, Inches	One-Column	Two-Column	Three-Column	Four-Column
20	1.93	1.85	1.75	1.64
23	1.89	1.80	1.70	1.59
26	1.86	1.76	1.66	1.56
32	1.79	1.69	1.59	1.49
38	1.74	1.65	1.55	1.45
45	...	1.60	1.50	1.40

Theoretically one B. t. u. will heat 55 cu. ft. of air one deg. F., allowing for safety and simplicity in figuring; 50 cu. ft. is used, which makes the constant for one change 0.02 B. t. u. per degree difference in temperature.

In computing required radiation for well constructed residences and office buildings, good practice allows one change of air per hour; well constructed store buildings, two air changes per hour. For buildings of loose construction and those employing some method of forced ventilation, more air changes per hour will be considered, depending upon the existing conditions of building and ventilating system.

To compute the radiation required in any room:

First—Compute the B. t. u. required to heat the air in the room by multiplying the cubical contents by the proper factor. Second—Compute the B. t. u. lost through the doors and windows by multiplying their area by the proper factor. Third—Compute the B. t. u. lost through the walls, floor and ceilings in the same manner.

For steam radiation (one to three lb. pressure)—Divide the sum of these results by 250 and the quotient is the number of square feet of straight steam radiation required.

For vapor radiation (with radiator traps)—Divide the sum of these results by 240 and the quotient is the number of square feet of vapor radiation required.

For atmospheric radiation (with extra cooling surface)—Divide the sum of these results by 200 and the

quotient is the number of square feet of atmospheric radiation required.

For hot water radiation (water at 170 deg. F.)—Divide the sum of these results by 165 and the quotient is the number of square feet of hot water radiation required.

	B. T. U. Per Sq. Ft. Per Hr. Per Deg. Dif. in Temperature
Wall Coil:	
Heating surface 5 sq. ft., long side vertical	1.92
Heating surface 5 sq. ft., long side horizontal	2.11
Heating surface 7 sq. ft., long side vertical	1.70
Heating surface 7 sq. ft., long side horizontal	1.92
Heating surface 9 sq. ft., long side vertical	1.77
Heating surface 9 sq. ft., long side horizontal	1.98
Pipe Coil:	
Single horizontal pipe	2.65
Single vertical pipe	2.55
Pipe coil 4 pipes high	2.48
Pipe coil 6 pipes high	2.30
Pipe coil 9 pipes high	2.12

RULE No. 2

This formula is to be used for computing the required steam radiation for a building, assuming a temperature of 70 deg. inside, with an outdoor temperature at zero, with 13-in. brick walls or average frame construction. Windows, single glass, set tight, and assuming one and one-half changes of air per hour in the building.

$R = 0.008C + 0.08W + 0.35G.$

R = Required steam radiation with system using steam at 1 to 3 lb. pressure.
C = Cubic feet of space to be heated.
W = Square feet of exposed wall surface.
G = Square feet of exposed glass surface.
No allowance is made for extreme exposures.

RULE No. 3

This rule can be used for computing required hot water radiation for a building, assuming a temperature of 70 deg. inside with an outdoor temperature at zero, with 13-in. brick walls or average frame construction. Windows, single glass, set tight, and assuming one and one-half changes of air per hour in the building.

$R = 0.013C + 0.12W + 0.53G.$

R = Required hot water radiation with average temperature of water in system of 170 deg. F.
C = Cubic feet of space to be heated.
W = Square feet of exposed wall surface.
G = Square feet of exposed glass surface.
No allowance is made for extreme exposures.

The concrete steamship Atlantus, the first of her type to have been delivered from an Atlantic shipyard and the second concrete ship to be operated in Atlantic waters, was turned over by the Shipping Board recently to the Raporel Steamship Line of New York for operation in the West Indian service of that company. The Atlantus was built in Wilmington, N. C., and is of 3000 tons.

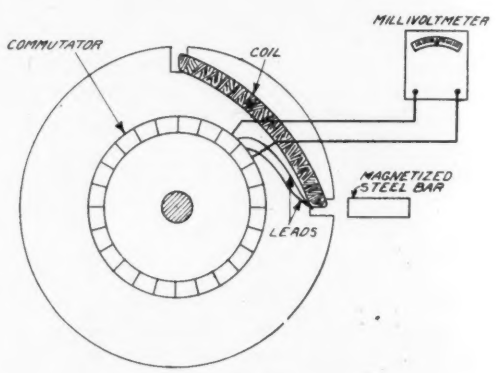
A "sit-down method" won't do a minute in this age of aggressiveness.

Locating a Reversed Armature Coil

BY MAURICE S. CLEMENT

IN armatures where both leads of a coil are taped to, and led out from an identical point, there is considerable danger of getting the leads crossed while connecting, thus reversing the direction of the flow of current in that coil. Such a reversal will in all cases "light out" as though perfect when tested with a lamp, but will cause bucking when the machine is run. A reversed coil of this sort is unusually difficult to locate and in many cases a whole machine has been stripped because ordinary methods of testing failed to locate the trouble. The most efficient test the writer has as yet been able to discover, and one that has never failed to work, is illustrated in the accompanying sketch.

It will be noticed that a millivoltmeter is used rather than a voltmeter because of the great sensitiveness of the former. Both terminals of the meter are connected to adjacent commutator bars. Next take a piece of metal which has been magnetized and move it in a direction corresponding to the revolving of the armature directly above the coil to which the meter is connected.



METHOD OF LOCATING REVERSED ARMATURE COIL

It is well to keep in mind the fact that if a clockwise motion is used on the first coil, the same direction must be retained on all remaining coils, otherwise the meter reading will be backward. On the downward stroke of the magnetized bar and as it approaches the coil to be tested, magnetic lines of force will travel from the bar to the coil, thence to the meter, causing the needle to fluctuate slightly. If the needle jumps ahead on the downward stroke, it will jump backwards on the upward stroke, and vice versa. The reversed coil will read opposite from the others.

To change the direction of the fluctuations of the needle, either reverse the meter terminals or the direction of the magnet.

A new heat insulating material, composed of a mixture of a special clay and cork, has been discovered by a Norwegian engineer. The clay and cork mixture is burnt, and the result is the formation of a very light substance that is said to be eminently suitable for all heat insulating purposes.—The Valve World.

Proposed Refrigerating Code

AS OUTLINED FOR MUNICIPAL AND STATE REGULATION FOR REFRIGERATION MACHINES AND PLANTS; APPROVED BY THE COUNCIL OF THE A. S. R. E.

THE purpose of the code is to provide for safe installation and operation of refrigeration and ice plants and is in legal form for passage by city and state governing bodies. At the beginning are the legal data and phrases necessary for enactment. Then come the regulating sections.

Section 1 states the application to every refrigerating machine using ammonia, carbon dioxide, ethyl chloride or sulphur dioxide as a refrigerant. The balance of the section is concerned with definitions of "refrigerating machine"; "large,' having 3 T. or more capacity or containing 100 lb. or over of refrigerant, and "small," of less than 3 T. or having under 100 lb.; "pressure imposing element," the compressor or absorber and generator; "safety valve," "automatic bypass valve," "liquid receiver," "cylinder," "main suction and main discharge valves," "capacity," which is taken as the builder's rating in tons refrigeration per 24 hr. These definitions are as usually understood by engineers.

Section 2 covers equipment of safety valves, one or more of which must be provided for every "large" machine, connected to the discharge line between the main discharge valve and the pressure imposing element, set to relieve excessive pressure and sealed. Sizes specified are for machines of

From 3 to 25 T. capacity	½-in. valve
From 26 to 60 T. capacity	¾-in. valve
From 61 to 100 T. capacity	1 -in. valve
From 101 to 175 T. capacity	1¼-in. valve
From 176 to 250 T. capacity	1½-in. valve
From 251 to 450 T. capacity	2 -in. valve
From 451 to 900 T. capacity	two 2 -in. valves

For ammonia, valves are to open at 300 lb. or less.

For carbon dioxide, valves are to open at 1800 lb. or less.

For ethyl chloride, valves are to open at 60 lb. or less.

For sulphur dioxide, valves are to open at 150 lb. or less.

Section 3 provides for an automatic bypass valve between the main discharge valve and the pressure imposing element, recommended to be of the same size as the safety valve and set, for ammonia, at 250 lb.; for carbon dioxide, at 1500 lb.; for ethyl chloride, at 50 lb.; and for sulphur dioxide at 120 lb. Discharge will be to the suction side of the pressure imposing element.

Section 4 deals with the liquid receiver. This is to be tested by combined hydrostatic, and hammer or other approved vibratory test before being put into service, and every receiver containing 25 lb. or more of refrigerant and having check valve, stop valve, or both between the condenser and receiver is to have a ½-in. safety valve, with no stop valve between it and the receiver, set to discharge to atmosphere.

Pressures for test and safety valve setting are as follows:

For systems using	Test press., lb.	Safety valve setting, lb.
Ammonia	500	350
Carbon dioxide	3000	2000
Ethyl chloride	150	100
Sulphur dioxide	250	200

Sections 5 and 6 provide for fire emergency. For all machines carrying 25 lb. or more of refrigerant, means is to be provided for discharging. For "small" machines this may be two ½-in. safety valves, one connected by an emergency line to the discharge line from the pressure imposing element between the main discharge valve and the condenser; the other is to be connected to the suction line between the evaporator and the main suction valve; both to be set for pressures as given for "large" machines in Section 2. In case ammonia is to be discharged into water, a check valve may be inserted in the emergency line to prevent water from entering the machine, but no other valve is permitted in the emergency line.

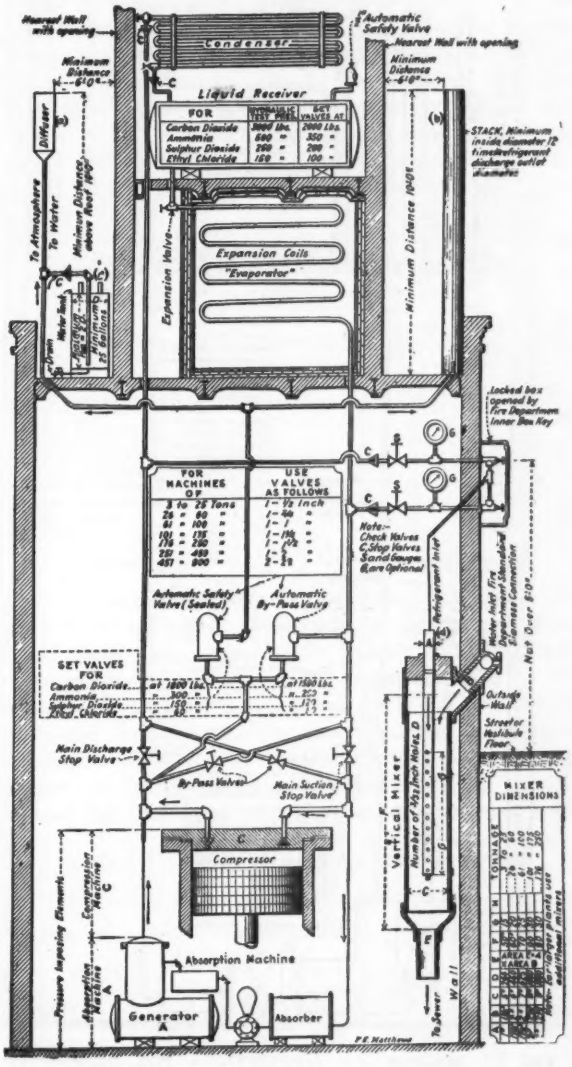


FIG. 1. DIAGRAM OF CONNECTIONS AS PRESCRIBED IN SAFETY CODE FOR A REFRIGERATING PLANT OF 3 T. CAPACITY OR OVER

For "large" machines, hand operated valves sim-

ilarly connected are to be located on the public thoroughfare side of the building wall or in a vestibule having glass panel doors giving easy access to the street. These valves must be not over 5 ft. above street or floor level, protected by a locked box to which only members of the fire department have access. But the emergency

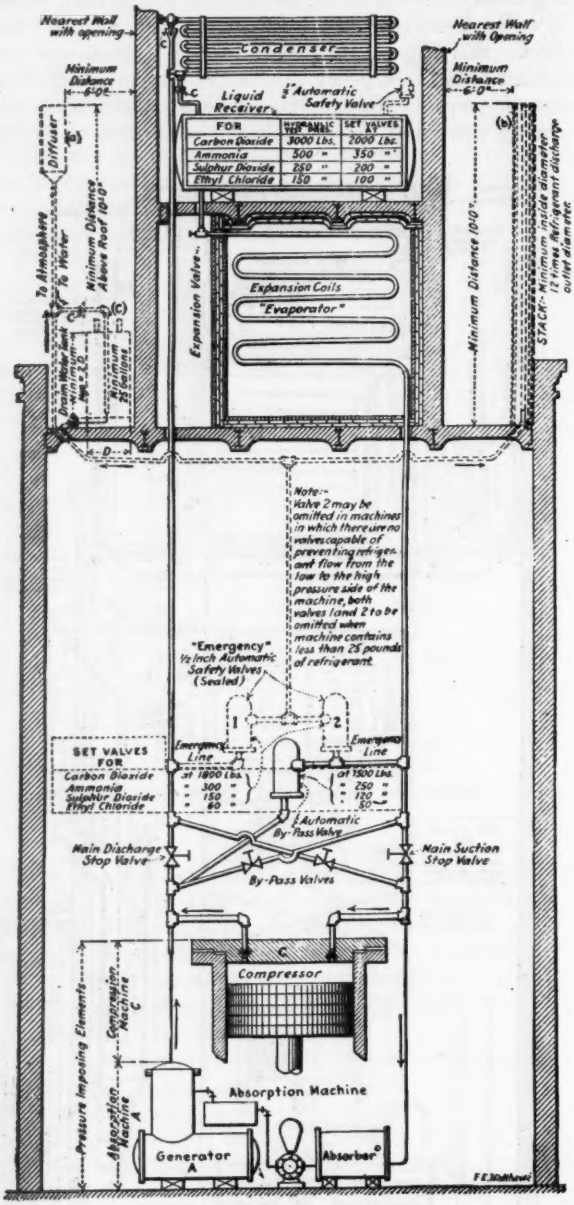


FIG. 2. DIAGRAM OF CONNECTIONS FOR REFRIGERATING PLANTS OF LESS THAN 3 T. CAPACITY. IF LESS THAN 25 LB. REFRIGERANT IS CARRIED IN THE SYSTEM, ½-IN. SAFETY VALVE ON LIQUID RECEIVER MAY BE OMITTED; ALSO CHECK OR STOP VALVE BETWEEN CONDENSER AND RECEIVER

lines may have check valves, pressure gages and auxiliary stop valves for repair purposes only, and the fire department may allow access to the locked box by those authorized to make repairs. The auxiliary stop valves are to be located inside the buildings, as near as possible to the emergency valves, and to be sealed "open," except when making repairs.

The locked box is to be labeled "FOR FIRE DEPARTMENT USE ONLY." The high-pressure valve to be labeled, "HIGH PRESSURE AMMONIA," and the low-pressure valve, "LOW PRESSURE AMMONIA," the name of the refrigerant used being substituted where it is other than ammonia.

If ammonia is used, it is to be discharged into the sewer through a mixer as shown later, and a sign in the box must read, "DO NOT OPEN VALVES UNTIL WATER IS FLOWING INTO THE MIXER."

In "small" machines having no stop or check valves which can prevent flow of refrigerant to the high-pressure side, the emergency discharge line safety valve will serve for the fire requirement and also to protect the liquid receiver, as in Section 4.

Section 7 deals with the discharge of refrigerant from safety or fire emergency valves, either into atmosphere or water. When discharged to atmosphere, the refrigerant is to be carried by continuous piping to an outlet turned upward, and having a diffuser suitable to mix the gas with air without restricting the flow. The piping must be such as to impose a pressure of not over 10 lb. on the discharge side of the safety valve, and must have no connection in any way to a steam or plumbing system, nor any means whereby the gases might be ignited. The piping must not be subject to serious corrosion and the outlet must be at least 6 ft. from any wall in which there is an opening, or 10 ft. above the roof. For carbon dioxide, the diffuser may be omitted.

Discharge may be effected through a ventilating stack if its diameter is not less than 12 times that of the refrigerant outlet, and the first possible outlet of the stack satisfies the conditions given previously. No diffuser is required.

Ammonia may be discharged into a tank which contains 1 gal. of fresh water, not used for any other purpose, for every pound of ammonia contained in the machine, but in no case shall the tank contain less than 25 gal.

The tank is to have hinged cover or an inlet and a vent hole at the top, and no horizontal dimension shall be greater than half the height. The discharge line for refrigerant is to enter at the center of the bottom. The tank is to be firmly supported and braced, and have a valve at the bottom for draining.

When discharged to a mixer, this is to be of vertical type of dimensions shown in Fig. 1, and having a standard fire department Siamese connection, through which the fire department shall supply water under the necessary pressure.

Section 8 provides for helmets in such plants as may be designated by the Fire Commissioner, and Section 9 that no flames, arc lights or gas jets are to be used in refrigerating machinery rooms where ammonia or ethyl chloride are the refrigerants, except internal combustion engines with hot surface ignition, which may be started and run in the usual way.

Section 10 defines provisions for escape and ventilation. All rooms for machines containing 25 lb. or more of refrigerant must have a direct exit to the open air or to a room or hall from which gases can be excluded

by self-closing doors. Vertical and horizontal openings which permit passage of gases to parts of the building not a part of the refrigerating plant must be sealed or have self-closing doors. And all rooms must have adequate ventilation to the open air, direct or by means of suitable ducts. If mechanical systems of ventilation are used, the control must be easily accessible in case of fire.

Section 11 provides that cylinders containing refrigerant must be stored in a cool, well ventilated place, as remote as possible from danger by fires.

Whether required by law or not, these provisions embody the best thought of refrigeration experts as to safety precautions and should be put into practice in every plant for the sake of the employes and the plant.

The Diesel Engine---III*

COMPARATIVE EFFICIENCIES AND COST DATA OF DIFFERENT PRIME MOVERS. BY HERBERT HAAS

TABLE II shows the heat consumption and the thermal efficiencies of different types of prime movers at continuous full load. The high figures of fuel consumption refer to small plants, the low figures to larger plants; they represent good economy in well-operated plants equipped with modern high-grade machinery.

TABLE III presents fuel-cost data covering the operation of the prime movers represented in Table II, while cost data covering the various types of fuel used in the prime movers represented in Tables II and III are presented in Table IV.

FORMULA FOR COMPUTING FUEL COST

FUEL is usually the principal item of expense in generating power. Because of the great variety of fuels and their differing greatly in heating value and other properties, all fuel prices should be reduced to a common basis of absolute cost per 1,000,000 B.t.u. The cost of 1,000,000 B.t.u. actually converted into mechanical work is then;

$$\frac{\text{Cost of 1,000,000 B.t.u}}{\text{Over-all thermal efficiency of plant}}$$

The fuel cost per effective horsepower-hour is:

$$\frac{\text{Cost of 1,000,000 B.t.u.} \times 2545}{\text{Over-all thermal efficiency} \times 1{,}000{,}000}$$

In this expression, 2545 B.t.u. is the heat equivalent to 1 English horsepower per hour.

SIGIFICANCE OF COST DATA

TABLES III and IV give the fuel prices and heat values of different kinds of fuels, the absolute heat cost of 1,000,000 B.t.u., and the cost of 1,000,000 B.t.u. converted into mechanical work. The heat cost of 1 hp.-hr. has also been computed for the different kinds of engines, based on average fuel prices in widely different sections of the United States. The figures mentioned indicate that, although the absolute fuel price for fuel oil may be several times higher than that of coal in the same market, power may be generated more cheaply with the Diesel than with the steam engine. However, the figures given are representative of continuous full-load conditions, at which power plants seldom operate. At fractional loads, the economy of the steam engine decreases; there is also additional fuel consumed to make up for boiler and producer losses when firing up or banking fires, and there are stand-by and radiation losses which increase materially with fractional loads. In the Diesel engine the fuel consumption increases only in proportion as the fractional load increases the internal work of the engine, with a decrease in its effective output. When the engine stops, all fuel losses stop.

How the size of units affects their economy is shown by Fig. 7. The Diesel engine has the highest fuel economy, which, moreover, is least affected by the size of the unit. The economy is nearly constant for all Diesel engines.

In Fig. 8 the average increase in fuel consumption with fractional loads is shown for the different prime

TABLE II. HEAT CONSUMPTION AND THERMAL EFFICIENCIES OF DIFFERENT TYPES OF PRIME MOVERS AT CONTINUOUS FULL LOAD

Type of prime mover.	Heat consumption per brake horsepower-hour.	Over-all thermal efficiency.	Superiority of Diesel engine.[a]
	B. t. u.		
Noncondensing steam engine [b]	40,000–28,000	6.30– 9.1	5.6–3.6
Condensing steam engine using superheated steam [b]	28,000–16,500	9.1–15.4	3.6–2.3
Locomobile engine with superheated steam and reheater, condensing [b]	17,000–15,200	14.9–16.7	2.4–2.1
Steam turbine, superheated steam, 200 to 2,000 horsepower [b]	24,000–15,500	10.6–16.2	3.3–2.2
Steam turbine, superheated steam, 2,000 to 10,000 horsepower [b]	15,500–14,000	16.3–18.1	2.3–1.95
Gas engine without producer	10,400– 9,300	24.4–27.5	1.33–1.28
Suction gas engine [c]	14,000–11,200	18.1–22.7	1.95–1.55
Diesel engine	8,000– 7,200	32 –35.3	

[a] Figures in this column are to be used as factors with which to multiply values in preceding column.
[b] Figures include boiler losses.
[c] Figures include producer losses.

TABLE III. COMPARATIVE OPERATING COSTS OF DIFFERENT TYPES OF PRIME MOVERS

Type of prime mover.	Kind of fuel.	Average cost per 1,000,000 B. t. u.	Cost of 1,000,000 B. t. u., effective work.	Heat cost per one effective horsepower-hour.
		Cents.	*Cents.*	*Cents.*
Noncondensing steam engine [a]	Coal	12	191–132	0.48–0.34
Condensing steam engine using superheated steam [a]	do	12	133– 78	.34– .20
Locomobile engine with superheated steam and reheater, condensing [a]	do	12	81– 72	.21– .18
Steam turbine, superheated steam, 200 to 2,000 horsepower [a]	Coal and anthracite	12	113– 74	.29– .19
		11	104– 68	.27– .17
Steam turbine, superheated steam, 2,000 to 10,000 horsepower [a]	do	12	74– 67	.19– .17
		11	68– 61	.17– .155
Gas engine without producer	Natural gas, coke-oven gas, or blast-furnace gas	15	63– 55	.16– .14
		7	27	.7
Suction gas engine [b]	Anthracite	11	61– 49	.16– .14
Diesel engine	Petroleum	15–18	56– 43	.14– .11

[a] Figures include boiler losses. [b] Figures include producer losses.

TABLE IV. COSTS OF VARIOUS KINDS OF FUEL

Kind of fuel.	Price of fuel.	Heating value per pound.	Absolute heat cost per 1,000,000 B. t. u.	Average heat cost per 1,000,000 B. t. u.
		B. t. u.	*Cents.*	*Cents.*
Lignite	$1.00 to $2.50, ton of 2,000 pounds	5,000– 9,000	10 –14	12
Bituminous coal	2.00 to 4.00, ton of 2,000 pounds	11,000–14,200	9 –14	12
Anthracite	2.50 to 4.00, ton of 2,000 pounds	14,500	8.6–13.8	11
Fuel oil (petroleum)	.75 to 2.25, barrel	18,000–19,000	12.5–37.5	15–18
Natural gas	.10 to .75, 1,000 cubic feet	900– 1,000	11–75	15
Blast-furnace gas	.05 to .01, 1,000 cubic feet	90	5.5–11	7
Coke-oven gas	.02 to .05, 1,000 cubic feet	450	4.4–11	7

* Abstract of Bulletin 156 of the Department of the Interior, Bureau of Mines.

movers, based on actual engine performance in well-operated plants. To obtain economy of steam plants at fractional loads, the full-load economy for a given size of plant can be taken from Fig. 7 and then the percentage increase computed for that size from Fig. 8.

With inexperienced labor and insufficient care of machinery, the fuel consumption of the steam and the suction gas power plants may be still higher than is shown in the figures.

From the data that has been presented, it is evident that small steam plants cannot compete with Diesel engines in the cost of generating power. On the basis of results of the actual operation of steam and of modern Diesel-engine plants, allowance being made for the special factors favoring the Diesel engine, such as small space requirements, constant readiness for immediate operation, cleanliness, and absence of danger from possible boiler explosions, steam plants up to 1000 hp. using

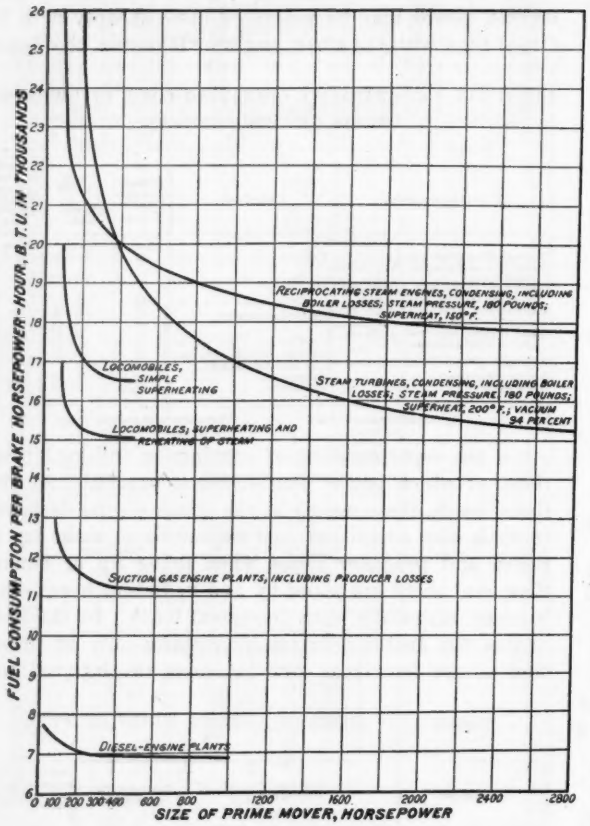

FUEL CONSUMPTION PER BRAKE HORSEPOWER-HOUR, B.T.U. IN THOUSANDS
SIZE OF PRIME MOVER, HORSEPOWER
RECIPROCATING STEAM ENGINES, CONDENSING, INCLUDING BOILER LOSSES; STEAM PRESSURE, 180 POUNDS; SUPERHEAT, 150° F.
LOCOMOBILES, SIMPLE SUPERHEATING
STEAM TURBINES, CONDENSING, INCLUDING BOILER LOSSES; STEAM PRESSURE, 180 POUNDS; SUPERHEAT, 200° F.; VACUUM 94 PER CENT
LOCOMOBILES, SUPERHEATING AND REHEATING OF STEAM
SUCTION GAS ENGINE PLANTS, INCLUDING PRODUCER LOSSES
DIESEL-ENGINE PLANTS

FIG. 7. INFLUENCE OF SIZE IN EFFICIENCY OF DIFFERENT PRIME MOVERS AT CONTINUOUS FULL LOAD

coal costing 10c per 1,000,000 B.t.u. cannot effectively compete with Diesel-engine plants, even with fuel costing 30c per 1,000,000 B.t.u.

Conditions Making Other Plants Desirable

When a supply of natural gas, coke-oven gas, or blast furnace gas is available, the gas engine is generally the logical selection. If the heat price of these gases, as well as the load factor of the station is very low and the load is highly fluctuating, large steam-turbine plants are the correct economical selection at present, as they cost less per kilowatt of capacity. The reduction in capital cost overbalances any fuel saving possible with gas engines, this saving being relatively small, because the absolute fuel consumption for the limited kilowatt-hour output of such stations is small.

The selection of the steam engine in small units when power is to be transmitted electrically to motors is justified only when the exhaust steam can be used either for heating buildings or in industrial processes.

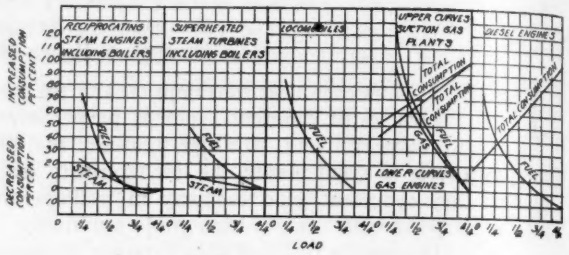


FIG. 8. AVERAGE INCREASE IN FUEL CONSUMPTION BY DIFFERENT PRIME MOVERS AT FRACTIONAL LOAD

The steam turbine has the advantage of lower installation cost, smaller space and foundation requirements, and oil-free steam. The steam consumption of small turbine units is, however, materially higher than that of steam engines; their use is therefore warranted only when the amount of heat to be supplied by the exhaust steam is very large.

Observations

What a Cripple Can Do if He Wants to; Some Remarkable Cripples. By H. A. Cranford

THE man who knows from his association with other people that he is above average intelligence is not necessarily an egoist; it's when he starts boasting of the belief in himself that he becomes a nuisance.

I met an engineer a few days ago who is, without doubt, a very brainy fellow. Everybody who meets him finds it out in a short time, because he goes into details to impress you with the fact. But I couldn't help but think that if this intelligence of his were put to other use, rather than to impress other people with his superiority, he would be a more successful man.

This brings me to a conversation I recently had with an employer of labor, regarding employment of cripples. When I asked him if he had ever considered using a cripple in his work, he replied that he had found that most of the cripples were always full of argument and ready to take the opposite side of any question that was brought up, especially if they were men who were self-supporting. His idea was that they were, as a rule, inclined to be rather sensitive and overbearing.

My experience with the large number of cripples with whom I am acquainted, I am sorry to say, partially justifies this man in his opinion. I have found numbers of them with a chip on their shoulder. But there is a reason for all this: After the misfortune, the cripple looks for work. He is given very little consideration by the average employer; in other words, it's very much like a returned convict looking for a position. Finally he succeeds in establishing himself and makes good. His

friends then begin to crowd around and compliment him on the wonderful showing that he is making. Very few men can stand flattery. The first thing he knows, he has decided that he is a superior being, and the fact that he has made good under his handicap makes him feel that a mere two-handed fellow can't do or know as much as he does.

He credits himself with his success, and loses sight of the merciful God who makes it all possible. When this arrogant, egotistical spirit asserts itself, he becomes obnoxious to others. Observation has convinced me of this fact; a large per cent of the cripples are sour minded or arbitrary as a result of one or two things—they have had to fight for a place in the sun or have been thoroughly spoiled by flattery.

God created men equal. They are not all equal today because some have thrown away their birthright. Every man has a God-given right to be something and have something; but his right does not conflict with any other man's, and when we try to usurp the other fellow's rights, then trouble starts. I have found that a lot of cripples consider their more fortunate fellow man their legitimate prey. As long as they can get by, regardless of the methods used, they seem to think it all right and proper. On the other hand, I have heard this expression from the physically whole man: "That fellow stung me for such a sum, but he is a cripple and I let him go without prosecuting him."

Such an attitude as this is wrong, as it puts a premium on dishonesty on the part of the cripple. What the great mass of cripples need is to be treated just exactly like the other fellow.

I believe in the law of compensation; as we sow, we shall reap. Look at the world through smoked glasses, and we see things darkly. If the cripple is grouchy, he will find people grouchy toward him. We get, in a measure, what we give.

I wish that it were possible for me to talk with every maimed soldier and every maimed civilian as soon as they try to begin over again and beg, beg, beg them not to allow themselves to become irritable, sour minded or disheartened. That is what we have to fight. Don't allow yourselves to feel that every man's hand is against you, for such is not the case.

When you are refused a chance, put yourself in the other fellow's place for a few moments. Before you were crippled, would you have thought that a cripple could have filled the place you asked for? I guess not. But don't give up. Use your brain for more argument. Believe in yourself absolutely. You can do anything you want to do, if you keep your temper. You may have to play politics a little sometimes, but that's considered good practice nowadays.

There are thousands of chances for you. You do not have to go into work that is distasteful to you. Make up your mind to work at the thing you like. Every few days I run across or hear of a cripple doing something unusual. Only a few nights since I heard a man playing a harmonica. I stopped to investigate. This man had suffered from a disease of the throat that resulted in an operation. There was a tube inserted in his neck, just below the chin, through which he breathed. He held the harmonica in front of the tube to play it, and the music was good. He is the only man I ever heard make a harmonica sound like anything. He was not a beggar; he was giving something for the money he was getting, and he was getting quite a lot of it, too. I could not but wonder at the patience that he must have had to learn to do this.

The best penman I know is a man who has neither hand. He does copying for a living and supports his family well. I also know a carpenter contractor who has his left hand off at the wrist. All he asks of the men working for him is to do as much in a day as he does. He doesn't use artifical apparatus, and does any kind of wood work.

In a town in west Tennessee there's a young fellow who is the most badly deformed human I ever saw, about the only part of him resembling a man being his facial features. Physically, he is more like a frog. He has to wear skirts and walks with his hands. He is an expert accountant and has held several city and country offices. He has made good money and saved it, until he owns his home and other property. He educated himself, with the exception of a short time in the grammar school.

I could name numbers and number of cases where cripples have done remarkable things. Then why shouldn't they succeed in doing those things that are more common? It's all in the man and the view he takes of things; and the critical time is when he first recuperates after the misfortune. It is to be hoped that Congress will not do anything to hamper the start that has been made toward helping the maimed; and, still better, they must be brought to the realization that some provision must be made for the 26,000 made cripples annually by industry. It will be a great thing for society when it is made possible for the cripple to be independent, rather than a beggar.

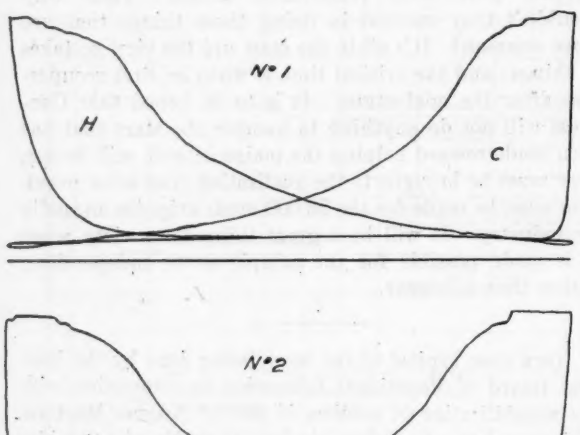
ONE CASE typical of the work being done by the Federal Board of Vocational Education in connection with the rehabilitation of soldiers is that of August Martens, who served as a first class blacksmith on board a sacrifice ship. When off the coast of France on their third venture an explosion occurred, wrecking the ship. A hot spark lodged in Marten's left eye, causing total blindness therein and affecting the right eye. The shock of the explosion impaired his hearing and generally affected his nervous system, and as a result the following eight months were spent in a hospital.

Just before his discharge from the Naval Hospital, he was informed of the provisions of the Rehabilitation Act. Upon his arrival in Seattle, he went to the Federal Board Office. All possibilities having been considered, the problem resolved itself into this: an earnest, willing worker with an unusual degree of mechanical ability and a keen interest in electricity, but handicapped with poor vision and hearing. With the concurrence of the eye specialist, Marten was recommended for a course in the electrical power plant of the City Light and Power Co. of Seattle, where he made exceptionally fine progress. Upon completion of his training a position was found for him in Seattle, and he is now winding armatures at $4.00 per day.

Remedy for Pound in Engine

HAVING recently had some experience which is a little different from what we run across every day, I thought the details might be interesting.

I have in my care a mongrel engine; the frame, pillow-block, crank shaft, tail block, crosshead and connecting rod are the remains of an old Greene engine; the flywheel and governor are from an old Harris Corliss and the cylinder, piston and rod and valve-gear are the new Harris-Corliss-Brown type. This engine is a 26 by 48-in. noncondensing, running 85 r.p.m. and belted to the main shaft; steam is supplied to the throttle at 100 lb. gage.



CARDS TAKEN IN SEARCH OF CAUSE FOR POUNDING

When I took charge of this engine it had never had credit for running satisfactorily for any length of time. There was no indicator on the job, and of course everything was mostly guess work. I was told that if the wristpin brasses were not adjusted frequently, in fact every day, the engine would surely pound. One set of crank brasses had already been split, and soon after I came a crack developed in the new set.

The crankpin was too small anyway, being but 4 in. in diameter by 4½ in. long, and I had a 5 by 5-in. pin put in. Of course the smallness of the pin was not responsible for the failure of the brasses, but the strap was loose by a good sixteenth of an inch which allowed the brasses to cramp back and forth until they cracked. We had to have a new strap on account of the larger pin and brasses and as care was taken to secure a good fit, there is probably little danger of breaking another set of brasses.

These things, of course, had nothing to do with the wristpin pounding. After a while I persuaded the management to purchase an indicator and I found the trouble and a temporary cure.

After dividing up the cutoff, which was very far from even, the knock continued and I began to study the diagram to see if there could be anything about the valve setting to cause the trouble.

The knock occurred entirely on the head end, that is, as the crank was passing the head end center, and I found by increasing the compression on that end that I had a very quiet running engine; but as I was not satisfied as to the cause of the pounding, I experimented still farther, and when diagram No. 1 was taken, the engine still ran quietly without any jar, even though there was practically no compression on the crank end, but as soon as I began to take away compression from the head end the jar commenced, and when a little more was taken away a real pound began.

I went to extremes to try to determine what brought about these conditions, and by doing so I found out what really was the matter. Somebody must have slipped up when the engine was rebuilt, as the actual dead centers are not where they should be.

The level line through the center of cylinder, guides and crank-shaft leaves the guides out, that is to say, while the cylinder and crank-shaft compare all right, the guides are running uphill toward the crank, and while it is only a small fraction of an inch (not quite a sixteenth), it is enough to cause the trouble, and while it can be remedied by raising here and lowering there, you, who have undertaken such a job, after an engine has been running for nine or ten years, know what the task is likely to be, and as long as it sets solid and runs smooth and quietly, I am not looking for the job. Of course, the belt pull would not be as even with a valve-setting as shown by diagram No. 1, so to compromise I gave more than was necessary to the crank end producing a diagram like No. 2.

Nobody can find any fault with the way the engine runs and if I did not tell them, they would never mistrust that a mechanical imperfection exists.

One of the things which helped me to look for the trouble where it was, was the fact that while the gasket was perfect between the cylinder and frame, it was almost impossible to draw the joint together tight enough that it would not leak, but by slacking up on the bolts that hold the chair to the foundation and by squeezing

the top of the joint very tight, I was able to draw up the bottom enough to make a joint.

I also found upon calipering the cylinder that it was wearing faster on the bottom at the head end than it ought under normal conditions, although that is usually the place they wear the fastest.

Another little imperfection I found, seemed funny for a few minutes, but there is always a reason for everything. I was given to understand that the clearance in this cylinder was 5/16 in. at each end; but as the pins both adjust on the inside, carrying the piston toward the head end, it got to where it bumped slightly, and when I had screwed the rod into the crosshead one turn to try it, the piston touched the other head, and as the thread on the rod is six to the inch, I couldn't quite see how I had moved the piston ⅝ in. I found by actual measurement that there was only 5/16 in. clearance on both ends instead of one, and as I thought there must be a cause for it, I investigated until I found that the follower plate had never been faced off and there were lumps on it which protruded fully 5/16 in. beyond the edges of the junkring. In this case, I have had to compromise until a new follower plate can be obtained or this one machined.

L. M. Reed.

A Dilapidated Power Plant

I was instructed to inspect the boiler room of a hotel situated on the Atlantic Coast and which was commandeered for the express purpose of remodeling it into a hospital for convalescing soldiers.

There were two Stirling boilers, hand fired, with herringbone grates, low setting, rated at 150-lb. pressure, operated at 150 hp., set in 1909. The boiler tubes were so thin in places that, when applying a center punch, a slight hammer blow sent the punch through the wall of the tube. Fifty-four tubes were condemned in one boiler and 29 in the other. Automatic stop valves did not work; valve discs did not close down on their seats and were unreliable. Blowoff valves were below the floor level in a pit, leaking and encrusted with scale. There was no plug cock between blowoff valve and mud drum. Ash pit doors were cracked and had been repaired with strap iron. Lost baffles had been replaced with fire brick. This baffling was not cemented and, of course, short-circuited the gases flowing around the baffling. The water columns were in leaky condition, gage glasses milky with scale, gage glass fittings green from the chemical action of the scale and water, try cocks absolutely missing on one of the water columns, and those on the other boiler too full of scale to permit of lifting by hand. The insulation of the piping had entirely disappeared. Glass faces of steam gages were missing, and water leaking past the dials indicated the necessity of new gages.

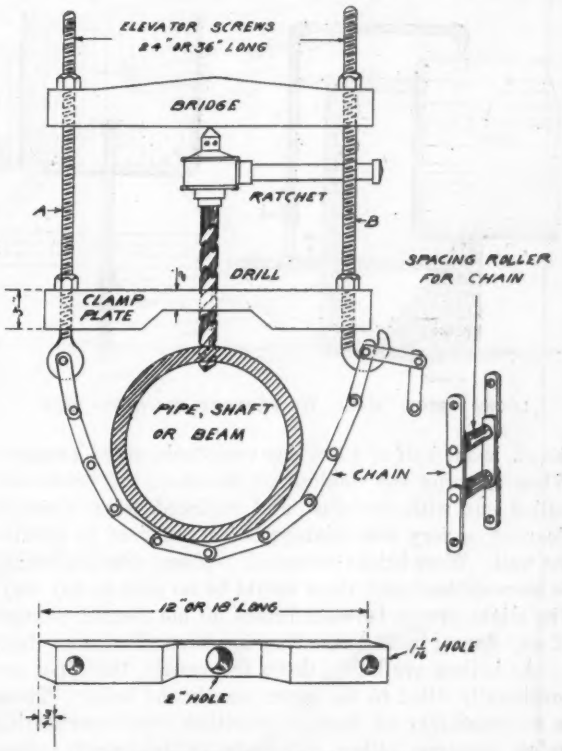
The top of the forced draft wind box formed the bottom of the ash pit. This tended to force the ashes over the front of the mud drum when the draft was on. Ash handling was difficult because the floor of boiler room was 4 ft. below the street surface, and the water meter set at the entrance of the boiler room between the boilers and the door. Thus, ashes had to be handled twice. The exhaust from the steam engine was piped up inside of the chimney to the top, instead of passing it through the feed-water heater. This heater took live steam from the boiler to heat the feed water. The feed-water pump follower rings were cracked and the piston scored, but it managed to feed some water into the boiler. Engine crosshead guides had to be rebabbited, as they had been running iron to iron. The top of the frame was cracked but had been welded on. The cylinder and piston were scored, packing was worn and loose, Corliss gear out of alinement and knocking, and the valves were not set for proper lap and lead. The separator insulation was missing and the drain plugged.

Investigation into the water conditions disclosed the fact that the town had decided to use their own wells instead of purchasing water from a neighboring town. At times the salt marshes would overflow into the wells and no further attention being paid to this water, as far as chemical analysis was concerned, the result is apparent.

S. Rosenberg.

Ratchet Drill Holder

The accompanying illustration is of a ratchet drill holder that has been found to be a time and money saver in the installation or repair of power plant machinery. The assembly shows the tool complete and a pipe in position for drilling, preparatory to clamping the tool solid to the pipe.



DRILL HOLDER ASSEMBLY AND PARTS

The sketch shows plainly how the holder is made. The two elevator rods consist of ⅞ or 1 in. by 24 or 36 in. round steel, made as shown in A and B. The clamp iron and bridge are 12 or 18 by 3 by ¾ in. The chain should be 1 in. by 48. long, or still longer, in order to take the largest ratchet drilling job to be found in the plant.

Otto Dorthen.

Blowoff Pipe Protection

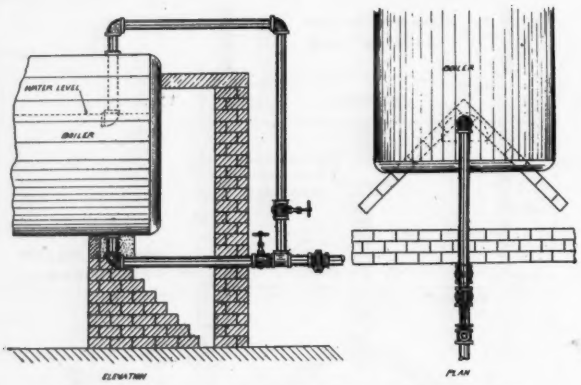
JOHN THORNE, in Aug. 15th issue, writes on blowoff pipe protection and shows a good arrangement of pipe, which is the same as on the boilers in my charge.

When installed, however, the pipe, after leaving the boiler, led directly to the side wall, thence outward through the rear wall to the main blowoff pipe, to which the top blowoff was also connected.

The pipe in the combustion chamber, at right angles to the direction of flow of gas, was very objectionable and difficult to protect, as, owing to local conditions, the outlet of the main pipe was almost as high as the bottom of boiler, so it was exposed to an intense flame.

It was then changed to lead directly from an ell, which was connected by a very short nipple to the boiler flange, through the rear wall to the main pipe, the top blowoff being changed to meet the new condition. Valves are so placed that either top or bottom blowoff can be used.

I protect this pipe and ell by a very simple and inexpensive arrangement. Old fire brick are built up, forming a V-shaped wall, as shown in the illustration, no cement being used. Inside of the V, to further protect



LOOSE BRICK WALL TO PROTECT BLOWOFF PIPE

the ell, is one-half of a fire clay receptacle called a sagger. When cleaning the combustion chamber, the bricks are pulled out with the dust and replaced when through cleaning, a very few minutes being sufficient to rebuild the wall. Were bricks cemented in place, cleaning would be more difficult and there would be no gain in any way. The slight cracks between bricks do not permit passage of any flame; in any case they are soon filled with dust.

As boilers are blown down frequently, the pipes are continually filled to the water line in the boiler. There is no possibility of damage resulting from overheating unless someone either carelessly or ignorantly closes either one of the valves, which should be left open.

Another safeguard which I use to prevent blowoff becoming filled with scale when using a scale remover, is a wooden plug in the outlet from boiler. To insure removal of this plug before closing boiler, I have attached to it a piece of heavy wire which is fastened to the outside pipe, making it impossible to replace handhole plate without removing the plug from the boiler.

When washing out, I use a piece of heavy coarse brass screen rolled up to fit inside blowoff, allowing it to project about six inches above the bottom of boiler. No scale of any size can get through, but water and mud can. Even if that should be left in, no harm could result, as it is too heavy to be washed down the pipe and the passage is not restricted very much.

HARRY H. YATES.

Convenient Devices Easily Made

OLD STRAP HINGES may be put to good uses such as illustrated. Figure 1 shows how an excellent broom holder can be made. A hole to take the handle is drilled and a slot cut in it, then the hinge is secured at the proper height from the floor on the wall. The broom is just slipped in the slot and let go; the sharp edges clamp it in place, the weight of the broom pulling the hinge shut.

The kink shown in Fig. 2 is another good way to use an old hinge, making a quick acting lock for a sliding window. The hinge has one point sharpened and then it is secured to the back of the window at a height that will make the lower half of the hinge dig into the sill when an attempt is made to open the window from the outside. To unlock it from the inside, the lower half of the hinge is simply raised.

Figure 3 shows how to use a hinge for shaft polishing and lapping tool.

Figure 4 is another handy homemade long work support made from a piece of pipe and a C clamp. It can be used at any desired location from the bench vise by clamping it to the edge of the work bench. The pipe is split and opened at both ends, one to form the V, the other to straddle the clamp to which it is riveted. The idea may be helpful, and also may bring forth better ideas from other readers.

An excellent heavy ram with a soft face can be made from a bar of iron or steel by tipping the ends of it with a chunk of brass, as shown in Fig. 5.

The end of the bar is drilled and tapped as also is one end of the piece of brass. The two are then connected together with a stud. Both ends of the bar could be tipped, thus giving more life to the bar.

When a pair of pliers become worn out in the jaws, there are many good uses to which they can be converted. A few of the uses to which I have put them are shown herewith. By clamping the jaws shut and drilling a series of standard size holes and tapping the holes for screws as in Fig. 6, handy screw pliers are easily made.

A gage dial pointer remover is made by heating the jaws and bending both at a slight offset, then filing a slot in the lower jaw, and putting a small pin in the upper jaw, as shown in Fig. 7.

Figure 8 indicates the manner the change is made to make a pair of punch pliers, that of drilling a hole in both jaws, putting a steel pin in the upper one for a punch.

Another use for an old can is that shown in Fig. 9. The top and bottom of the can are cut out and an opening is cut in the side, as shown. The tin is then slipped on over the wire guard of the portable light. The rays of the light can, with this shade, be directed into the ends of boiler tubes and other places with much ease.

The sketch also shows another simple tin can shade for boiler room log desk light. The flap that is bent back is nailed to an upright board at the back of the desk.

C. H. WILLEY.

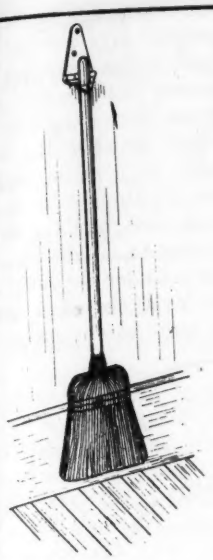


FIG. 1

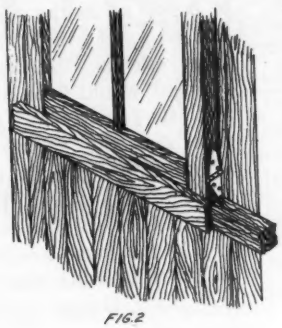


FIG. 2

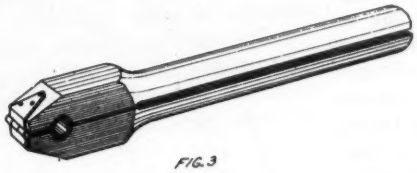


FIG. 3

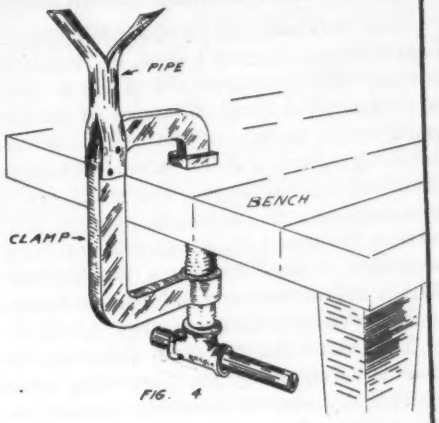


FIG. 4

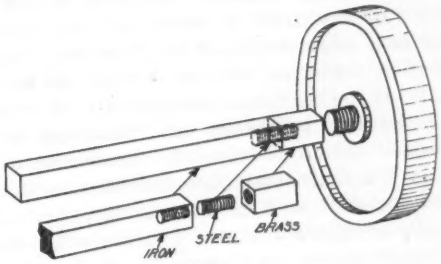


FIG. 5

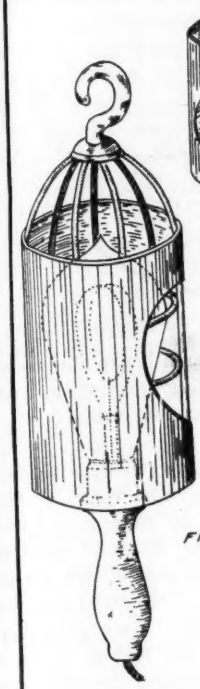
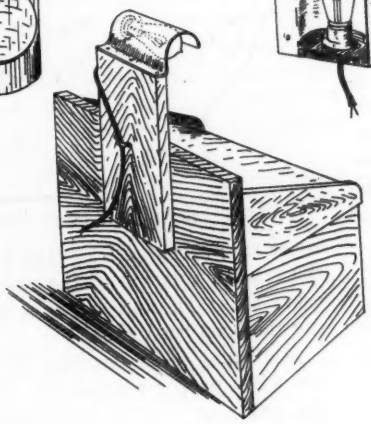
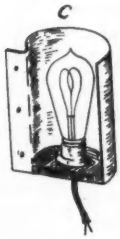


FIG. 9





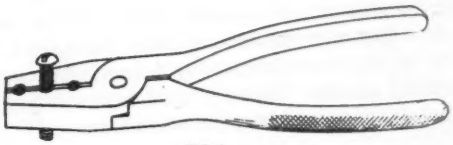


FIG. 6

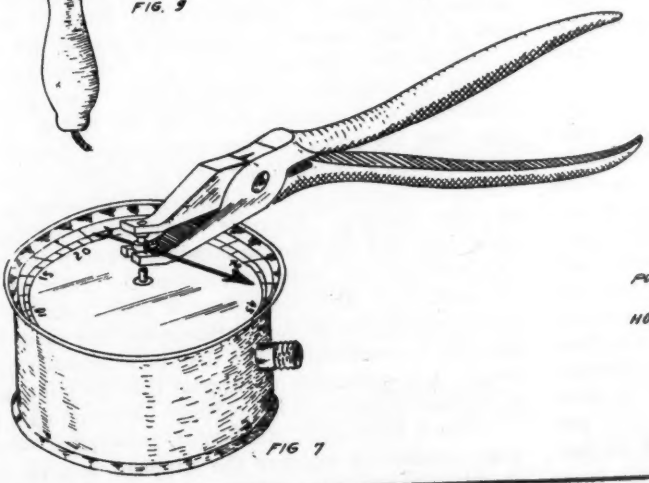


FIG. 7

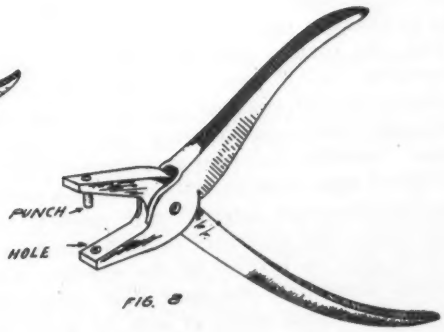


FIG. 8

CONVENIENT DEVICES EASILY MADE

Ball Bearing Lubrication

THE WHY and the How of Ball and Roller Bearing Lubrication in August 1 issue, by Reginald Trautschold, is very misleading in regard to slip or creep of the balls or rollers. The lineal difference of the two races is not taken up by the slip of the balls or rollers, but by the traveling member; if the outside race is stationary, the inside one will make practically 2½ rev. while the ball goes once around the course, and it is this difference between the travel of the ball and traveling member that takes care of the difference in the diameter of the races. With a 5¾ outside race and 4¾ inside, the creep cannot be measured by ordinary means. E. L. GAEDECKE.

Your claim that the lineal difference between the two races is taken up by the "traveling member," though theoretically correct, is rarely actually so, for the so-called "traveling member" as often as not does not travel. In any event it makes no practical difference so far as a measurement of the frictional resistance developed is concerned whether one of the races travels or not. If the frictional resistance to the creep or slide of the balls or rollers on the "traveling member" is less—as it should be—than to the sliding of the free race on the shaft, both races might as well be fixed—one to the shaft and the other to the hub. Ordinarily the balls or rollers will creep or slide on the race, rather than cause the race to slide on the shaft—the resistance to be overcome being less.

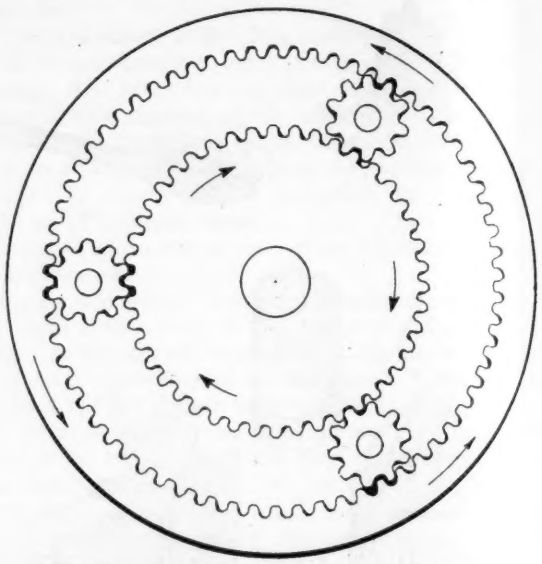
In any event, whether the free race travels or whether the balls or rollers creep on the race, something has to slide, and this sliding is proportional to the difference in the lengths of the bearing paths on the two races. This is a fact you cannot get away from, and the possibility of the lineal difference being taken up by the "traveling member" simply adds to the importance of adequate and proper bearing lubrication.

REGINALD TRAUTSCHOLD.

I READ with interest the article which appeared in the Aug. 1 issue, by Reginald Trautschold, entitled, "The Why and How of Ball and Roller Bearings." He may be right about the oil and grease part of it, but he certainly is wrong in speaking of the slippage of the rollers on the races. We know there is no such slippage as he speaks of, in fact we have gears meshing together on the same principle. J. N. WOODRUFF.

The comparison of a ball bearing with a planetary gear with the pinions meshing with concentric gears is interesting, but if you will study the mechanism more closely you will discover that it confirms the claim that slippage does occur between balls or rollers and the races. Consider, first your gear mechanism mounted in the hub of some rotating body, such as a pulley, and assume that the outer internal gear revolves with the rotating body. The planetary pinions would cause the inner spur gear to revolve in the opposite direction. This would necessitate the spur gear being mounted loosely on the central shaft, or axis, in order to allow the unavoidable slippage between the spur gear and the supporting shaft. Now, if instead of gears we substitute balls or rollers for the pinions and smooth races for the internal and spur gears a similar situation exists, with the one difference that there is no positive engagement between the rolling members and the supporting races. The same amount of slippage would have to occur as in the case of the gear arrangement, and this slippage would occur between those contact surfaces offering the least resistance. Obviously then, slippage would take place between the rolling members and the races, for the contact between the inner race and the supporting shaft is a plain bearing which offers greater resistance to slippage than does the contact between the polished races and the rolling members.

If we reverse conditions and consider the inner race as traveling with the shaft, or axis, the same actions take place, though perhaps not quite so obviously. The



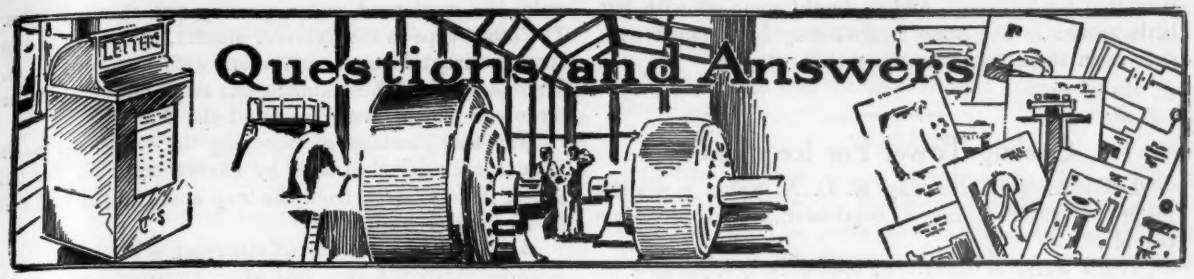
GEAR ARRANGEMENT IN WHICH NO SLIP OCCURS

outer race carries a load that acts as a brake and resists the reverse rotation of the race, so again slippage must occur and take place between the bearing surfaces offering the least resistance.

Ball and roller bearings are highly efficient mechanism when properly cared for, but the separation of bearing surfaces by the interposition of rolling members cannot overcome all sliding friction. Much of the friction of a plain bearing is overcome, it is true, but not all.

I hope this explanation may serve to straighten you out on the question of bearing action. Your misunderstanding is very common, but if you will look at the question from the point of view that contact cannot occur simultaneously between surfaces of different area you will appreciate the fact that slippage must occur in a ball or roller bearing. Slippage might occur between the outer race and the bearing housing, between the rolling members and the races, or between the inner race and the shaft, but occur somewhere it must. As the resistance between the rolling members and the races should logically be considerably less than between other bearing points, it is reasonable to suppose that the slippage will be confined largely—if not entirely—between such parts.

From a lubrication standpoint, however, it would be quite immaterial whether the slippage occured within or without the bearing proper. In either case, the amount of slippage would be measured by the difference in the circumferences of the two races, and proper lubrication supplied to combat it. R. TRAUTSCHOLD.



Efficiency of Absorption Machines

We have both compression and absorption machines and desire to calculate the efficiency of the absorption machine, and will be pleased to know the method for doing so. We know the actual tons duty of refrigeration, but theoretical ton duty, which is necesasry to calculate the refrigeration plant has not been determined. Our plants are all refrigeration, brine cooler operation, so can easily determine the amount of range and flow of brine.

In one of our compression systems, which has a 50-ton Frick machine on a 23 to 30 ton duty, we get a refrigerating plant efficiency of only 60 per cent, when a similar machine, doing the same duty, but 20-ton capacity, gives 79 per cent efficiency.

We have examined the valves, clearance and rings, but can find no evidence of defect. We have a steam indicator, and suggested to the operator that he take an indicator card, but he says the card cannot be taken satisfactorily. While I know brass valves and fittings are not suited to ammonia gas, nevertheless do not believe that a few cards would hurt the indicator.

Have suggested that the thermometer wells be placed in the suction side of the compressor, but find the minimum temperature of gas around 5 deg. F. when the outlet of brine from the cooler is —8 deg. F.

Will you be good enough to advise on the above problems? R. S. F.

A. Without knowing a great many facts about the individual absorption system under discussion, it is impossible to give any accurate information as to a true way of figuring the theoretical capacity. The only assertion that can be made with truth is: The capacity of the entire system is governed or controlled by the heat absorbing power of the absorber. Every heat unit taken up by the ammonia must be absorbed by the weak liquor in the absorber.

Then the true theoretical capacity of the whole system will be the capacity of the absorber for taking up the evaporated ammonia loaded with heat units.

But the theoretical capacity will be much greater than the actual, as the conditions in the absorber change. Scale will accumulate, thus reducing the rate of heat transfer. Also the weak liquor will be delivered to the absorber at a higher temperature as the weak liquor cooler becomes dirty.

The rated capacity as given by the manufacturers can be taken as the theoretical capacity, with a fair allowance made for general operating conditions.

An efficiency of 60 per cent can be considered good when a 50-ton compressor is only required to do from 23 to 30 ton duty. One very plain reason for this lies in the fact that the load is so easily handled that no special effort is made by the operators to effect fine economy.

The 20-ton compressor must be handled with care and real ability to get the over-capacity duty. This alone is sufficient reason why the efficiency is 79 per cent.

It will not harm the brass parts of an indicator to take cards from an ammonia compressor.

If brass is kept in contact with ammonia for a long time, dezincification will take place. The ammonia will attract and finally destroy the zinc, which is one of the alloys of brass.

By all means use the brass-fitted indicator for the ammonia compressors. Only be sure to clean it carefully after using and give it a good coating of light oil.

Indicating the ammonia compressor is important, as it will show defects of valve action and leakage. But thermometers placed in the liquid line close to the expansion valves and in the suction line and discharge line, close to the compressor, are more helpful than indicator cards.

As brine coolers are in use, each one should be provided with four thermometers. Readings should be taken at brine inlet and outlet and also the temperature of the liquid ammonia passing the expansion valve and the ammonia vapor leaving the cooler must be taken.

By studying the operating conditions and comparing the temperature readings under varying conditions, it will be found that results can be greatly improved.

A. G. Solomon.

Placing Locomotive Tires

For the benefit of G. W. M. on page 745, Aug. 15 issue, I will say that he can remove locomotive tires by the following method: First make a gas burner by bending a coil of ½-in. or ¾-in. pipe long enough to go twice around the tire. Drill holes the full length of the pipe on the side next the tire. When the tire is expanded by heating with this burner, it will loosen and be readily removable.

To replace the tires, heat in a hot fire and when putting them on to the wheels, place thin steel shims between the wheels and tires. R. G. S.

I have noted the inquiry of G. W. M. in the August 15 issue of Power Plant Engineering for information in reference to removing and placing locomotive tires. In well-equipped railroad shops they are put on and removed with hydraulic presses. But where equipment is lacking for such repairs, the same results may be obtained by placing the wheel on a level blocking of brick or iron and then heating the tire to a cherry red by building a fire around it. The tire may be removed after getting

it to that heated stage, and it should come off with but little trouble. The same method may be pursued with success in shrinking a new tire on a wheel.

H. W. Rose.

Cooling Tower For Ice Plant

I do not quite see why E. L. A. wants a cooling tower; I should think a condenser would solve his trouble.

If his water is difficult to secure or is expensive, he could use the water from his ammonia condenser over his steam condenser and then, with a reservoir or large tank to receive it and a cooling tower to recool it, he could use the same condensing water over and over with but little make-up.

If his plant is large enough to warrant the installation of such, a water softener would be a good thing.

B. C. White.

I note the inquiry of E. L. A. in Aug. 15 issue of Power Plant Engineering. He is entirely correct in the idea of a cooling tower for his ice plant, and his next step is not only to install one correctly but the kind most practical for his need.

I judge from the explanation that the water is used over and over and that E. L. A. is running condensing. If the plant is so located that he could provide a reservoir which would hold sufficient water and then erect a spray tower on this reservoir, I believe that by that system the desired results can be obtained. There are numbers of instances where water for steam boilers has been used and reused so many times until all of the mineral properties have been used up and as the water, to work perfectly in a boiler, has to have a certain percentage there of, and if there is not any in the water it will react upon the boiler by pitting. So for that reason I suggest a reservoir in the ground, instead of brick, concrete or wood, as the water coming in contact with the earth can abstract from the earth that mineral nature which is necessary for a good boiler feed water, and again I would advise also putting the water from the deep well directly into this reservoir, also allowing it to throw off a certain portion of its mineral quantities which is causing this boiler scale. He may eliminate boiler scale 50 per cent if the water can be first placed in an earthen tank before being used in the boilers. I would also recommend a good boiler chemical to treat the water, and when a good chemical is used I unhesitatingly state, without any inquiry to boiler whatever, that 95 per cent of scale trouble will be entirely eliminated.

H. W. Rose.

Economizer Operation Questions

I have noted with interest E. E. A.'s questions on page 745 in the Aug. 15 issue. He is not explicit enough in his question to give the reader a clear idea as to the information he wants. I think the answer to question 4 might possible go a little further into detail.

We have in operation two kind of slashers, one of which is known as the hot air slasher and composed entirely of coils of pipe, usually one and a half inches inside diameter. Steam at boiler pressure passes through these coils, the condensed water passing out through traps. The other type is the cylinder slasher, composed of two large horizontal copper cylinders with cast iron heads. There are two of these dumps, one small one and another large one which revolves around the shaft.

The usual method of removing the condensed water from a cylinder slasher is by having traps on the tail pipes, the discharge from the trap going to the hot well or feed water heater.

I had the opportunity of observing several tests on a cylinder slasher, before and after improvements, which resulted in a saving of 40 gal. of condensed water per hour were made. In this case the steam trap was originally on the same floor as the slasher. It was removed from there and the tail pipes of the slasher were continued to a point through and just beneath the floor, and there connected to the top of a large cylinder 18 in. in dia. by 5 ft. long placed horizontally. From the bottom of this tank a connection was made through the original trap to the hot well.

The idea of this change was to secure an additional reservoir for the water so as to take it away from the slasher as fast as it was condensed. The logical question may arise in the minds of some that the trap was too small. That point was, however, thoroughly tested out by using a trap of twice the rated capacity necessary; and even by doing so, the proper results were not obtained. The fact is that slasher condensation seems to occur by spurts, and a trap even twice the size would fill up and still leave water in the slasher.

The coils in E. E. A.'s question, I presume, belong to a hot air slasher system, and if that is the case and his slasher is located higher than his boiler, I think that he will save considerable money, not only in his fuel bill but in traps and in maintenance, if he will discard all of his pumps, tanks and steam traps, and have a boiler shop build him a drum of the same strength as his boiler. This should be placed underneath his slasher and be connected to the tail pipes of his steam coils. From the bottom of this drum a return line back to the boiler should be installed and connected a considerable distance below the water line. If placed above the water line, it would be likely to cause water hammer. A cut-off valve and a check valve should be installed at some convenient point in this line. The cut-off valve will permit necessary repairs to the check valve in case of trouble.

H. W. Rose.

Proper Installation of Globe Valves

How should globe valves be placed, with the pressure against the bottom or the top of the disk?

W. S. Van W.

A. In placing any kind of a globe valve, it is customary to so arrange the valve as to bring the pressure under the disk. In doing so, should the disk become disconnected from the stem, it will be possible to either open or close the valve, while with the pressure above the disk, the valve would be held closed at all times, regardless of the position of the stem.

Someone is saving what you spend foolishly. Who is depositing your dollars? Invest them in W. S. S. and save them yourself.

Effect of Increased Governor Weights

I SHOULD APPRECIATE it very much if you would answer the following question and explain reasons for your answer. Considering an ordinary Corliss engine flyball governor, if the weight of the flyballs were increased what effect would it have on the speed of the engine? G. E. S.

A. The effect of increasing the weight of the flyballs on a Corliss engine governor would depend on the type of the governor. If this is of the weighted type—that is, if it has a heavy weight which is lifted by the flyballs along the governor spindle—increasing the weight of the flyballs will cut down the speed of the engine.

The reason for this is that the centrifugal force of the flyballs has to lift the counterweight as well as lifting their own weight, and if their weight is greater in proportion to the total weight of balls and counterweight, it will give the balls power to lift the weight at a slower speed.

If the governor is of the non-weighted type, having no counterweight and simply moving the knockoff cams of the admission valve, then the balls simply have to lift their own weight (neglecting the slight weight of the governor rods), and as the centrifugal force increases in proportion to the weight, making the balls heavier will simply add both to the centrifugal force

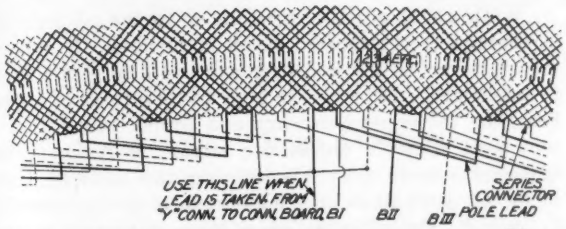


FIG. 1. INTERNAL STATOR CONNECTIONS FOR G. E. 20 AND 60 HP. AND 4 AND 6 POLE 440-V. INDUCTION MOTORS

and to the weight to be lifted, and this will have no effect on the speed at which the balls will rise.

There will, however, probably be a little slower action of the governor on change of speeds, because of the increased inertia of the balls; that is when they are running at a certain height it will take a greater change in speed to cause them to rise or fall than would be the case before the weight was increased.

Induction Motor Connections

KINDLY PRESENT me with diagrams showing internal and external connections for G. E. 20 and 60 hp. and 4 and 6 pole 440-v. induction motors. R. A. F.

A. These diagrams of connections are as shown in the accompanying illustrations, Fig. 1 showing the internal and Fig. 2 the external connections.

Steam Engine Valve Gears

WHAT KIND of valves has a Slater engine?

2. How would you calculate the safe working pressure of horizontal return tubular and water-tube boilers of the Stirling and B. & W. make?

3. How late will a Corliss engine cut off?

4. What type of engines employ loose eccentrics?

5. What is meant by "angularity of the rod"?

6. What has that to do with the toe?

7. Why is one toe on a Greene engine longer than the other? E. A.

ANSWERS

THESE ENGINES are of the drop cutoff type, cutoff being accomplished by the drop of multiported or gridiron valves. The ports have ample area, so there is little drop in the steam line. Exhaust valves are of the multiported rotary type.

Both admission and exhaust valves have removable seats, ground into cylindrical chambers. Separate steam and exhaust eccentrics are provided.

2. For calculating the safe working pressures of both fire-tube and water-tube boilers, the same formula is employed:

$$P = \frac{2\ Ste}{Df},$$ in which P=safe working pressure, S = tensile strength of boiler plate, t = thickness of plate in inches, e = efficiency of longitudinal joint, D = diameter of shell in inches, f = factor of safety (usually 5 or 6). S usually varies from 55,000 to 60,000 lb., and e may be obtained by reference to a table dealing with

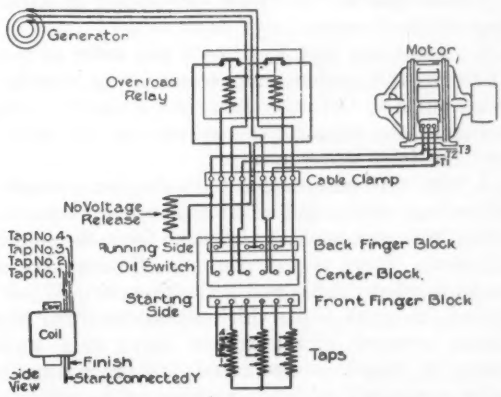


FIG. 2. EXTERNAL DIAGRAM OF CONNECTION FOR G. E. INDUCTION MOTOR WITH STARTING COMPENSATOR WITH OVERLOAD RELAYS AND NO-VOLTAGE RELEASE

the proportions and efficiencies of riveted joints. The shell is always taken to be that of largest diameter in any boiler.

3. In a Corliss engine operating with one eccentric the maximum cutoff is about half stroke, as the eccentric is set 90 deg. ahead of the crank and reaches its extreme throw by the time the piston has reached the half stroke. With two eccentrics, a cutoff up to about ⅞ stroke is possible.

4. An eccentric constructed in such manner that its eccentricity and angle of advance may be changed without stopping the engine is used on the automatic high-speed type of engine. This type of eccentric, which is called a shifting eccentric, is attached to the governor in such manner that the position of the governor controls the eccentricity and angle of advance, and by this means regulates the speed of the engine by changing the point of cutoff to suit the load carried by the engine. A device of this kind makes it possible to use the simple

slide valve and, at the same time, secure a variable cutoff in governing the speed of the engine.

5. Here it is assumed you refer to angularity of a connecting rod. When the crankpin of an engine stands at any point in its path of motion, except when on the dead center, the connecting rod forms an angle with the line of centers; this is termed the angularity of the connecting rod.

By the line of centers is meant a straight line drawn from the center of the crank shaft through the center of the cylinder.

The shorter the connecting rod is in proportion to the stroke of the piston the greater the angularity of the rod. Or the angularity of the connecting rod may be described as the equivalent, but not actual, shortening of the rod by its being deviated from the line of centers which it is at all times except when the crank pin is on the dead centers.

If the angle of advance or angular advance of the eccentric is in question, however, it is the angle (beyond 90 deg.) that the eccentric is advanced or pushed around on the shaft to bring the steam edge of the valve in line with the steam edge of the port, if the valve has lap. Or, if the valve has lead or both lap and lead, it is the angle the eccentric is advanced (beyond 90 deg.) to give an opening for steam, the engine in either case being on dead center.

6. Assuming that by "toe" you refer to the projection on the pusher cam, transmitting motion from the eccentric to the valve stem, the greater the angular advance of the eccentric the earlier will the pusher cam cause the inlet valve to open.

7. On a Greene engine the eccentric connects to a pusher cam crank, and when the pusher cam comes in contact with the latch of the valve stem the inlet valve is opened. There is just one cam; thus we are uncertain as to what the big and little toe refer. If you have in mind the toggle links which transmit motion from the exhaust eccentric to the exhaust valve stem, their difference in length is due merely to the nature of the toggle movement, and has nothing to do with the angular advance of the eccentric.

One of the best descriptions of this valve gear is found in "Valve Setting," by Herbert E. Collins. It will prove helpful if you can secure it at your public library.

Factors Governing Advisability of Using Superheated Steam

KINDLY inform me as to the various factors governing the advisability of using superheated steam.

J. F. W.

A. That superheated steam results in ultimate plant economy is evidenced by the fact that the largest and most economical plants in the world are equipped with superheaters. With very high pressures and temperatures, initial cost and upkeep may be offsetting the thermal gain due to the use of superheated steam, but in general a limited amount of superheat effects ultimate economy in nearly all cases. Practically all modern turbo-generator stations and large piston-engine plants are designed for superheated steam. No general rules can be drawn as to the extent of the saving made because of the great number of variable factors entering into the problem. Each installation must be considered by itself and due consideration given to such items as the type and size of prime movers, character of service, nature and cost of fuel, piping, first cost, upkeep and the like. The resulting net gain or loss will show whether or not the use of superheat is advisable.

Theoretically, all types of steam-driven prime movers show increased heat efficiency with superheated steam, but the gain is usually less than actually realized in the commercial mechanism. Aside from the gain in the prime mover, there is the possible added efficiency in the boiler plant. It is true that the heat required to superheat steam is furnished by the fuel, and when a definite weight is superheated, an added amount of fuel must be burned; but with a properly designed superheater integral with the boiler, the over-all efficiency of boiler and superheater is usually somewhat higher than if saturated steam alone were generated, so that the added amount of fuel is less than the heat gained by the steam. In addition to the thermal gain in the prime mover and boiler, there may be a reduction in heat losses in the piping system because smaller pipes may be used and because superheated steam gives up heat less rapidly than does wet steam. Furthermore, the increased economy of the prime mover may permit a reduction in the size of boilers, condensers and other auxiliary apparatus.

While there is little question as to the advisability of employing superheated steam in turbines, the advantages are not so marked in steam engines, particularly in small units; for with the high temperatures of superheat, the valves tend to warp and proper lubrication is somewhat difficult unless the engine is designed for superheat conditions. Considering the additional expense of equipment and maintenance of superheating apparatus, the ultimate gain in comparatively small reciprocating units appear to the negative.

Why This Emptying Tank?

IN GOING over the July 15 issue of Power Plant Engineering I noted the inquiry by R. A. F. regarding the mysterious emptying of a concrete tank, and I think I can offer a solution of the "mystery."

From such information as is given I am led to believe that the tank in question was located above the centrifugal pump, which supplied the surface condensers, and presumably the 6-in. pipe from the centrifugal pump discharge was either connected into the bottom of the tank, or brought over the top of the tank, and the end submerged.

Now let us see what happens when the centrifugal pump is supplying water to the surface condensers. R. A. F. states that the pump discharged against a 35-ft. head through the surface condensers "and out by gravity to the river 50 ft. below." But was the centrifugal pump working against a 35-ft. head?

The water space of the surface condenser no doubt was nearly or quite air tight, in which case after the centrifugal pump had established a flow through the condensers a vacuum would exist in the centrifugal pump discharge, due to the fact that the pump is located 15 ft. above the river level.

Assuming the foregoing to be the case, when the valve in the 6-in. pipe was opened, the vacuum in the 12-in. line pulled the water out of the tank, over through the condensers, and into the river.

Perhaps if R. A. F. will place a good vacuum gage on the 12-in. pipe, or, better still, a compound gage, as he will have pressure in the pipe when the pump is first started, he may learn something interesting.

Incidentally, it may pay him to elevate the discharge pipe from his condenser one or two feet above the top of the condenser before allowing it to drop to the river and put a good-sized vent to the atmosphere at the highest place, as I will wager that his upper rows of condenser tubes are not filled with water, unless his condenser is of different design than most surface condensers.

I hope R. A. F. will inform us if my diagnosis of the case is correct. C. B. HUDSON.

Cleaning Air Compressor Cylinders

HOW COULD I clean the interior walls of an air compressor cylinder? Would kerosene be good for that purpose? SUBSCRIBER.

A. Under no conditions use kerosene or coal oil for cleaning the interior walls of air compressor cylinders. This is very dangerous and should be prohibited.

We would suggest that you use strong soap suds or soda water, feeding this freely through the lubricator. After cleaning, operate the machine so as to insure lubrication sufficient to prevent rust.

Dynamo Brush Troubles

I AM HAVING more or less trouble with my generator brushes sparking. I have reset the brushes and have a good, clean commutator. They will run all right for about 12 hr. and then will start to spark again. I would be very much obliged if you would give me an explanation as to what the trouble might be. P. McQ.

A. Many causes contribute to the sparking of brushes, and, as a consequence, it would be difficult for us to determine just what your trouble may be. All we may be able to do is to offer a few suggestions.

It is possible that your brushes are either too hard or too soft for the service required. This would cause more or less sparking. Then again, the brushes may be of such a nature as to cause the commutator bars to wear away more rapidly than the mica between the bars. When this occurs, as you readily can understand, the brushes will have a tendency to make extremely poor contact with the copper bars, and with the result that they spark. This naturally will aggravate the condition, and more serious sparking will result.

We would further suggest that you carefully check up on the spacing of the brushes to see that they are spaced equidistantly one from another and, after this has been done, note whether or not they are in the neutral position. This may be determined by shifting the brushes with the load. A neutral plane will be located where no sparking exists.

Due to the fact that the brushes on both your machines are causing you trouble, it is not probable that anything definite, such as a short circuit or open coil, exists within your armature. If such were the case, it would hardly be possible that both armatures would be affected alike.

Another cause of this trouble which occurs to us is that perhaps the commutator and brushes are suffering, due to lack of proper lubrication. We would especially judge this to be a possible cause, due to your statement that they will run in good condition for about 12 hr. and then start sparking again.

There are many forms of commutator compounds on the market, application of which will not only prevent sparking but also undue wear of both commutator and brushes. Going over the commutator lightly with a piece of paraffin will assist materially in providing proper lubrication. The writer has had considerable experience along this line, especially so in connection with brushes used on large railway generators, and has found that good results could be secured by lubricating the brushes with paraffin. This may be done by placing a number of pieces of paraffin in a shallow pan, heating the paraffin, and immersing the brushes in the molten paraffin for a period of about 12 to 16 hr; the brushes so treated will run satisfactorily for a period of about 30 days.

Power-Speed Relation in Gearing

IS IT NOT TRUE, when using gears to drive machinery, that what you gain in power you lose in speed? For instance in the case of chain blocks, how are heavy weights lifted with so little a pull?

In using gears to drive any machine, is there a gain or loss of power?

For instance, on direct connecting the back gearing on a lathe the speed is increased and if the back gear is put in the cut can be much heavier. Which consumes the most power to drive? F. H.

A. You are quite correct, that what you gain in power you lose in speed, in any system of gearing or pulleys.

In the chain block, the heavy weight is lifted slowly by a small pull moving rapidly. The amount of power expended in lifting the weight is the same as the amount that would be required by lifting directly, or somewhat greater, on account of the friction of the block.

The same is true in regard to a gear. When the back gear is put in on the lathe, the driving belt from countershaft is at the same speed as before, but the cut is much slower, therefore a bigger pull can be exerted at the point of the tool.

Of course, it takes more power when the speed is reduced, because of the extra friction of the mechanism.

Water for Storage Batteries

MAY sulphuric acid having a specific gravity of 1.400 and mixed with water formed by melting snow be used as electrolyte for storage batteries? V. K. S.

A. It is not wise to use water from melted snow for filling storage batteries, as there is likely to be a good deal of dirt mixed with it.

Filtered rain water is usually all right, as it is free from any dissolved matter, except sometimes a little sulphuric acid, but it should be filtered to get out the dirt and dust.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Office

(Established over 23 years.) Formerly PRACTICAL ENGINEER PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.

537 South Dearborn Street, Chicago

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1919, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue 23,100.

CONTENTS

Handling Coal and Ashes with Electric Hoists. By James Monroe. Illustrated....801
Deadly Work of Flywheel....804
Fuel Conservation Letters. By Joseph Harrington. Illustrated....805
Developing Hydroelectric Power Sites. Illustrated....806
Vacuum—II. By Roger Taylor. Illustrated....809
Oxy-Acetylene for Pump Repairs. Illustrated....812
William L. Saunders. By Charles Austin Hirschberg. Illustrated....813
Converting a Steam Plant to Stand-By Operation. By L. M. Klauber. Illustrated....815
Trouble with the Foundry Fan. By Mark Meredith....817
Feeder Regulators—II. By V. E. Johnson. Illustrated....818
Rules for Computing Required Radiation. Illustrated....822
Locating a Reversed Armature Coil. By Maurice S. Clement. Illustrated....824
Proposed Refrigerating Code. Illustrated....825
The Diesel Engine—III. By Herbert Haas. Illustrated....827
Observations. By H. A. Cranford....828
Letters Direct from the Plant: Remedy for Pound in Engine. Ball Bearing Lubrication. Ratchet Drill Holder. Blowoff Pipe Protection. Convenient Devices Easily Made. A Dilapidated Power Plant. Pump Packing; Trysquare for Cutting Belt. Ball Bearing Lubrication. Illustrated....830
Questions and Answers: Efficiency of Absorption Machines. Placing Locomotive Tires. Cooling Tower for Ice Plant. Economizer Operation Questions. Proper Installation of Globe Valves. Effect of Increased Governor Weights. Induction Motor Connections. Steam Engine Valve Gears. Factors Governing Advisability of Using Superheated Steam. Why This Emptying Tank? Cleaning Air Compressor Cylinders. Dynamo Brush Troubles. Power-Speed Relation in Gearing. Water for Storage Batteries. Effect of Eccentrically Placed Rotor. Illustrated....835
Editorial: Industrial Training. First Step in Water Power Development....840
Getting Recommendations Across....841
New Plastic Arc Welding Unit. Illustrated....842
Electric Heating Furnace. Illustrated....842
Gas Masks and Lubrication....843
Chicago Pneumatic Headquarters in New York. Illustrated....843
News Notes....844

Industrial Training

There was a time in the history of our educational system when those prominent in school affairs feared we were inclined too strongly toward industrial work, with our courses in manual training and mechanical arts in schools and colleges. These courses, however, were planned as part of professional engineers' training and not as development work for the tradesman, and as such they have proved successful.

Today there comes a call from Colonel Woods, assistant to the Secretary of War, urging factory owners and industrial corporations throughout the country to undertake industrial training for their workers, at the same time to pay them a living wage during the period of their apprenticeship.

From the days when industrial workers were trained through apprenticeship directly under the employer to the present, when the training a tradesman gets is usually as helper to an employe whose interest in the development of the youth ends when he gets his weekly pay envelope, industry has gone through many changes necessitating different relationships between employer and employes, so that personal contact is no longer possible in large industries, and in its place many plans have been inaugurated in order that workmen may gain proficiency and skill in their trades.

Quantity production is today the outstanding need of the country in order that prices of necessities may be brought down rather than wages increased. But this cannot be done without greater efficiency among our workers, of whom, according to Colonel Woods, thousands are attaining only 35 per cent of their best human capacity. As a whole, he estimates that six million or more workers are now engaged in doing what reasonably could be done by four million, if proper industrial training were carried on in all factories of the country. He complains that "the United States spends seven hundred million dollars annually on general education. It spends five thousand dollars of public money on anyone who has sufficient means to live without wage-earning in the years between sixteen and twenty-one. But it seldom spends a single dollar on making a mechanic. Where millions are spent for a few thousand professionals, nothing is spent for the millions who produce our necessities."

We infer from this that Colonel Woods would shoulder the responsibility for our present labor unrest upon our educational system as a remote cause.

As to the power plant, we have only to look back to the work of the Fuel Administration as evidence of what can be done toward increasing efficiency as the result of educating those responsible for operation. The fact remains, however, that in educating the financial men back of the power plants in the value of modern equipment and fuel-saving devices, at least as much work was done as in instructing engineers and firemen.

By all means let us have industrial training, but let us not confine it to the training of the hands for quantity and quality production. Let it extend to those who must preserve our resources by saving fuel, light, water, steam, and to those who provide the equipment. At present this would have to be carried on by the industries,

but for future needs we believe it should be part of the work of our public schools and colleges, as the results affect every citizen of the country.

First Step in Water Power Development

The development of our natural water power sites is an industrial problem which has been too long neglected for the highest welfare of the country and it is encouraging to note that manufacturers of hydraulic machinery report marked increase in the sale of water wheels during the present year. To follow the trend of popular thought, however, and erect expensive hydroelectric plants wherever a stream of water shows evidence of power would be a big mistake, as many such projects could only result in failure of the plant to meet expenses.

Careful surveys of the power conditions surrounding the proposed site and its possible interconnection with other plants as well as the water supply and head available are essential if success is to be assured. Although more extensive development of our water power resources would result in the saving of fuel, which is the most expensive item in steam power plant operation, there are, as pointed out on another page of this issue, other engineering, legal and economic conditions surrounding many potential water power sites that offset the advantage which would be gained by the elimination of fuel cost. In order that all may be benefited by what power resources can be developed to advantage, each case should be given careful consideration and neither rushed into when a doubtful enterprise nor delayed where success is assured.

Getting Recommendations Across

WERE I to lay down necessary qualifications for getting every recommendation accepted by the one in authority I should state them in three words: honesty, knowledge, persuasiveness.

First of all, one's motive for a recommendation must be clean and above board, that is, he should be impersonal, dealing with the problem purely from the standpoint of what is best for the plant.

Then he must know what he is recommending, its cost, what it will do, how well it will do it in comparison with other devices or machines.

The persuasive element of the problem is entirely human and requires the most study on the part of the engineer whose mind is more accustomed to dealing with exact laws than with the shifting fancies of men's minds. For this reason it is this last phase of the problem with which we wish to deal in this article.

Let us assume that we wish to make a recommendation that will cost considerable money to put into effect, but that we have every reason to believe will be a paying investment. First of all, we will not take any chances in recommending any doubtful installation; in other words we will sell ourselves thoroughly on every phase of the question and stake our reputation on its success. Then, and not before, are we in position to take up the study of presenting it to the financial man.

The financier and the engineer do not think in the same language, that is not often; so it is necessary for one or the other to learn a new language. Since we as engineers wish our plans to go through it is advisable for us to learn the financier's language and run no risks of failure on this score. We shall thus have one lead in obtaining the owner's view point which is always well to obtain if possible before approaching him with a recommendation.

To obtain his view point is not at all easy in most cases; but to go about it systematically, let us find out what he knows about the subject. This must be done diplomatically as he will stand for no quizzing, but the subject might be approached and it will not take long to determine something in regard to his knowledge of it. His experience with similar apparatus is not usually a personal secret and knowledge of it can usually be gained about the plant. He may be a specialist in some branch of his industry; we will find this out and put ourselves in his position, if possible.

Having obtained the owner's view point we will put the recommendation to ourselves and be sure that we have a conclusive favorable answer to every question that is likely to come up. We cannot expect, however, to get an immediate acceptance of the recommendation, but we should be fully prepared to answer questions and go into details if called upon to do so.

Best results are sometimes obtained by a mere suggestion the first time the subject is approached. This gives the owner an opportunity to think and work out his own plans if he is so inclined. He works on suggestions like everybody else and if he puts his plan through successfully we must give him credit. If we are loyal employes we are after best results not methods, and should favor the best plans, not necessarily our plans.

Should, however, suggestion fail to bring results, we will present a complete outline of our recommendation in terms understood by the owner. Begin with a summary; follow with arguments for and against; close with a resume. Show why the recommendations are necessary or advisable and what is to be gained.

We shall leave this outline with him to study, for it is he who must make the decision now, as we have already decided and we should help him see the right way, not our way.

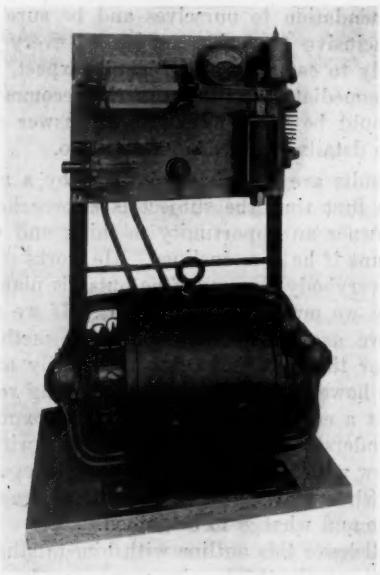
ELECTRIFICATION OF MOSCOW factories on a basis of turf fuel is in progress under the direction of the engineering staff of the Soviet Government, according to Arthur Ransome, to whom the scheme was explained by the President of the Supreme Council of Public Economy. "Russia in 1919," Huebsch.

"He said that there was no water power near Moscow, but big turf deposits which would be used as fuel, In order not to interfere with the actual lighting of the town from the power-station already in existence, they are taking the electric plant from the Provodnik works, which will supply enough electricity for the lighting of the town. As soon as that is set up and working, they will use it for the immediate needs of Moscow, and set about transferring the existing power-house to the new situation near the turf beds. In this way they hope to carry out the change from coal to turf without interfering with the ordinary life of the town. Eventually when things settle down, they will get a larger plant."

New Plastic Arc Welding Unit

THE new Plastic-Arc welding unit just placed on the market is composed of a dynamotor and current control panel. The generator is flat-compound wound, and maintains the normal voltage of 35 on either no load or full load.

As shown in the accompanying illustration the control panel contains many new features. It has been designed to provide a constant-current controlling panel, small in size, of light weight, simple in operation and high in efficiency. The panel proper is of slate 20 by 27 in. and on it are mounted a small carbon pile, a compression spring, and a solenoid working in opposition to the spring. The solenoid is in series with the arc so that any variation in current will cause the solenoid to vary the pressure on the carbon pile, thereby maintaining the current at the value for which it is adjusted.



DYNAMOTOR AND CURRENT CONTROL PANEL COMPRISING THE NEW PLASTIC ARC WELDING UNIT

This is the well known principle of the Wilson control of constant heat in the weld. Practically any metal can be welded with this outfit, without preheating or annealing.

Three switches on the panel provide an easy means of current adjustment between 25 and 175 amp. The arrangement of the welding circuit is such that 25 amp. always flows through the solenoid, when the main switch is closed, whether the welding current is at the minimum of 25 amp. or at the maximum of 175 amp. The balance of the welding current is taken care of in by-pass resistance shunted around the solenoid.

The outfit is available as a dynamotor unit, with standard motor characteristics as follows: 110 v., 220 v., D.C., or 220 and 440 v., 60 cycle, 2 or 3 phase, A.C., and also as a gasoline-driven unit, or it can be furnished without a motor for belt drive. The normal generator speed is 1800 r.p.m. The net weight of the outfit in standard characteristics is 800 lb. with D.C. motor, 807 lb. with A.C. motor, 1200 lb. with gasoline engine, and 550 lb. as a belted outfit without motor.

Electric Heating Furnace

AN electric tool-tempering furnace, which uses the barium-chloride and salt principle, is proving highly successful in an eastern manufacturing plant. The chief advantages of this type of furnace

FIG. 1. THE ELECTRIC TOOL-TEMPERING FURNACE

over those using gas, coke, oil or wood are constancy and ease of control of heat, cleanliness, equal heating of each atom of the specific part of the tool to be tem-

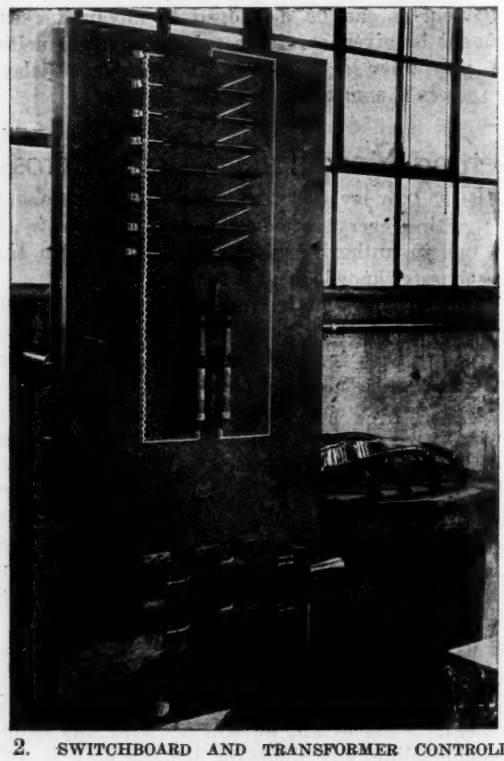


FIG. 2. SWITCHBOARD AND TRANSFORMER CONTROLLING 16 TO 30-V. ALTERNATING-CURRENT CIRCUIT ON ELECTRIC TOOL-TEMPERING MACHINE

pered, low cost of operation and excellence of the finished work.

Figure 1 illustrates the simple construction of the furnace. The outer shell, a cast-iron cylinder, is about 3 ft. high and 3½ ft. in diameter, which is packed with

fire brick and occasionally a layer of asbestos. The circular reservoir in the center, which forms the operating part of the furnace, is 12 in. in diameter and 14 in. deep.

The heat is supplied by two pairs of electrodes, built in on opposite sides of the walls of the reservoir. The electrodes operate on a 16- to 30-v. alternating-current circuit, which is controlled by the switchboard and transformer. Carbon sticks are placed between the electrodes in the reservoir to complete the circuit.

The current is started on the 30-v. circuit. Salt is fed into the reservoir, and when it is melted it acts as a conductor and completes the circuit. The carbon sticks are taken out. A mixture of Barium chloride and salt is then fed into the reservoir, the final proportion being about 60 per cent Barium chloride.

When the temperature of the liquid reaches 1425 deg. F. the voltage is lowered. The current regulation at the switchboard gives a quick and easy method of control, so that the temperature of the liquid can be held at any predetermined degree of heat required for each specific tool.

The liquid, kept at one temperature, heats the tool uniformly from surface to center and eliminates soft spots in the finished tool, which is seldom possible when a tool is exposed to a direct or indirect flame.

The furnace throws off little heat, so that it meets with the approval of the workmen.

Gas Masks and Lubrication

THE August issue of "Graphite" contains an interesting article titled as above and which is quoted in full below:

"In the endeavor of the United States Army officials to produce a carbon to be used in gas masks for the protection of soldiers against poisonous gases, search was made among all the available carbonaceous materials. The best possible absorbent was produced from cocoanut shell charcoal, with charcoal made of other nutshells close behind. A very exceptional charcoal or carbon was made from anthracite coal of about 90 per cent carbon, yet gas retort carbon of over 99 per cent could not be made into even a very poor absorbent.

"Upon further and most careful study and examination, it was found that the form or structure was the determining factor. It was discovered that charcoal, or carbon, produced from what had been vegetable matter, such as anthracite coal, or woody fibre, such as cocoanut shells, developed a honeycomb structure of very small pores, and because of these pores the poisonous gases were taken up or absorbed. Gas carbon formed no structure at all and would not absorb any of the poison gases.

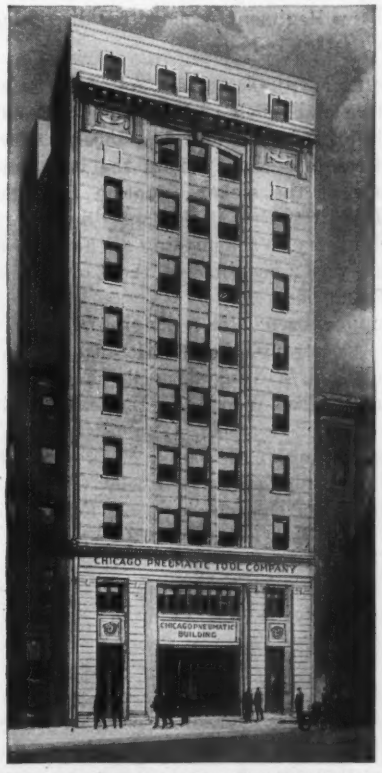
"It may seem a long way, or, as they say, a far cry, from poison gas warfare to lubrication, but here again the same principles are brought to light. In some experiments made in our laboratories to determine the wearing qualities of brasses under a load of eighty pounds per square inch, no appreciable wear was found when using the graphite which we put into our lubricants. But when these same brasses were rubbed the same length of time and the same number of times under the same pressure, using a graphite of the amorphous variety with a purity of over 99.5 per cent, the surface of the brass was scored and the loss in weight of brass was considerable.

"The explanation comes to us through the study and examination made by United States Army officials in their search. Flakes have a remarkably low coefficient of friction and when rubbed one over the other, easily and smoothly slide on their surface, as there are no projections to catch into. Amorphous graphite, however, is irregular in shape, so that all of the corners, as it were, catch with one another, and after some little time form a very compact, dense mass."

Chicago Pneumatic Headquarters in New York

THE Chicago Pneumatic Tool Co. plans moving its general offices from Chicago to New York and is erecting an office building at 6-8 East 44th Street, New York City.

The structure, which is being built by the Westinghouse Church Kerr Co., is of combination steel, brick,



NEW GENERAL OFFICE OF CHICAGO PNEUMATIC TOOL CO.

and limestone, and will comprise initially 10 stories, all to be occupied by the company. The ground floor is to be an atractively designed permanent exhibition room, in conjunction with which a completely equipped service station will be maintained.

There will be continued in Chicago a sales and service organization.

The new building is to be ready for occupancy early in 1920, at which time the transfer will be effected.

A GREAT opportunity will only make you ridiculous unless you are prepared for it.

News Notes

SEPTEMBER 22 to 27 will be a notable week for those interested in the chemical industries of the country. During that week the Exposition of Chemical Industries will be held at the Coliseum in Chicago, and the managers of the exposition state that it will be the most complete showing of chemical progress and methods that has ever been made. The exposition will be open from 12 noon until 10:30 p. m. each day.

In connection with this there will be meetings of the American Institute of Mining and Metallurgical Engineers at the Congress Hotel, and of the American Electro Chemical Society. Papers will be presented covering the fields of "Dyestuffs," "Ceramics," "Metallurgy," "Electric Furnaces," "Glass Manufacture," "Pulp and Paper Manufacture" and "Industrial Research." Motion picture films will be presented showing the processes in these various fields, this exhibition being in the Chemical Exposition Auditorium at the Coliseum.

Beginning Wednesday, the Technical Association of Pulp and Paper Industry will hold a number of meetings in the First Regiment Armory for discussing topics connected with this industry.

THE STOKER MANUFACTURERS' ASSOCIATION will hold its fall meeting at French Lick, Ind., on November 3, 4 and 5. This organization has had several very important committees in session during the year, and interesting reports of the stoker situation throughout the country will be presented at that meeting.

As a preliminary to the meeting of the general organization, there was a meeting of the Commercial Committee consisting of:

P. A. Poppenhusen, Green Engineering Co. (chairman); S. A. Armstrong, Underfeed Stoker Co. of America; S. L. Nicholson, Westinghouse Elec. & Mfg. Co.; F. B. Bigelow, Murphy Iron Works; W. H. Rea, Detroit Stoker Co.; R. C. Beadle, ex-officio, Combustion Engineering Corp.; and a meeting of the Engineering Committee consisting of: F. H. Daniels, Sanford Riley Co. (chairman); T. A. Marsh, Green Engineering Co.; Edwin Fitts, Detroit Stoker Co.; Geo. I. Bouton, Murphy Iron Works; H. F. Lawrence, American Engineering Co.; F. F. Espenschied, Combustion Eng. Corp.; J. G. Worker, Westinghouse Elec. Mfg. Co.; R. C. Beadle, ex-officio, Combustion Engineering Corp., on September 4 at Chicago, Illinois.

S. L. Nicholson, assistant to the vice-president of the Westinghouse Electric Manufacturing Co., is expected to have some interesting remarks to make on the future of business in the country.

ANNOUNCEMENT has recently been made that Morgan-Gerrish Co., 501 South Sixth St., Minneapolis, Minn., will represent the Steam Motors Co., of Springfield, Mass., in the Minneapolis territory.

THE JEFFREY MANUFACTURING CO. annuonces the opening of a branch office in Detroit in the Book Bldg. on Washington St., which will be in charge of Mr. O. B. Wescott, who has had long and successful engineering experience in the Sales and Engineering-Construction Department of the company and is well equipped to render assistance to clients in working out the most economical and practical material-handling equipments for their requirements.

GUY S. HAMILTON, Advertising Manager of the American Steam Conveyor Corporation, Chicago, has been appointed editor of the Booster, the corporation's newly established sales organ.

THE SMITH GAS ENGINEERING CO. has received a duplicate order for gas producer for The Kellogg Toasted Corn Flake Co., Battle Creek, Mich. The plant when completed will replace 450,000 cu. ft. of city gas a day.

E. L. SULLIVAN has been appointed to represent the Green Engineering Co. in the Pittsburgh district, including western Pennsylvania, eastern Ohio and western West Virginia. Mr. Sullivan has been a special representative for the McDonough Regulator Co. for the past 10 yr.; 6 yr. in Chicago and 4 yr. in Pittsburgh. He has devoted all of his time to special investigations pertaining to the securing of more efficient boiler and furnace operation.

THE U. S. CIVIL SERVICE COMMISSION announces an open competitive examination for aid, for men only, to fill vacancies in the Lighthouse Service, at a salary of $1200 a year, with possibility of promotion to $1380.

Applicants must have had the education or education and experience specified in one of the following groups: (a) At least senior student in civil, mechanical, or marine engineering in a college or university of recognized standing. (b) At least junior engineer in such course, with one year's engineering experience. (c) At least in sophomore year in such course with two years' engineering experience. (d) Graduation from a four years' high-school course, or the completion of a course of study equivalent to that required for such graduation, and three years of engineering experience. Applicants must have reached their twenty-first but not their thirtieth birthday on date of the examination.

This examination is open to all male citizens of the United States who meet the requirements. Apply for Form 1312.

THE UNITED STATES CIVIL Service Commission announces an open competitive examination on Sept. 30, 1919, for plant engineer, for men only. A vacancy at the United States Arsenal, Watervliet, N. Y., at $3000 to $3600 a year, and in positions requiring similar qualifications throughout the United States, at these or higher or lower salaries, will be filled from this examination. Certification to fill the higher-salaried positions will be made from those attaining the highest average percentages in the examination. The duties of this position consist of the design and education of construction work, and the maintenance of plant and equipment at the arsenals. The appointee will be in executive charge of all electrical, mechanical, civil, and architectural engineers, inspectors, and skilled mechanics. He will also have supervision over a large and varied force of draftsmen, most of whom are graduate engineers. Competitors will not be required to report for examination at any place, but will be rated on education, training and service. Applicants should at once apply for Form 1312, stating the title of the examination desired, Plant Engineer, to the Civil Service Commission, Washington, D. C.